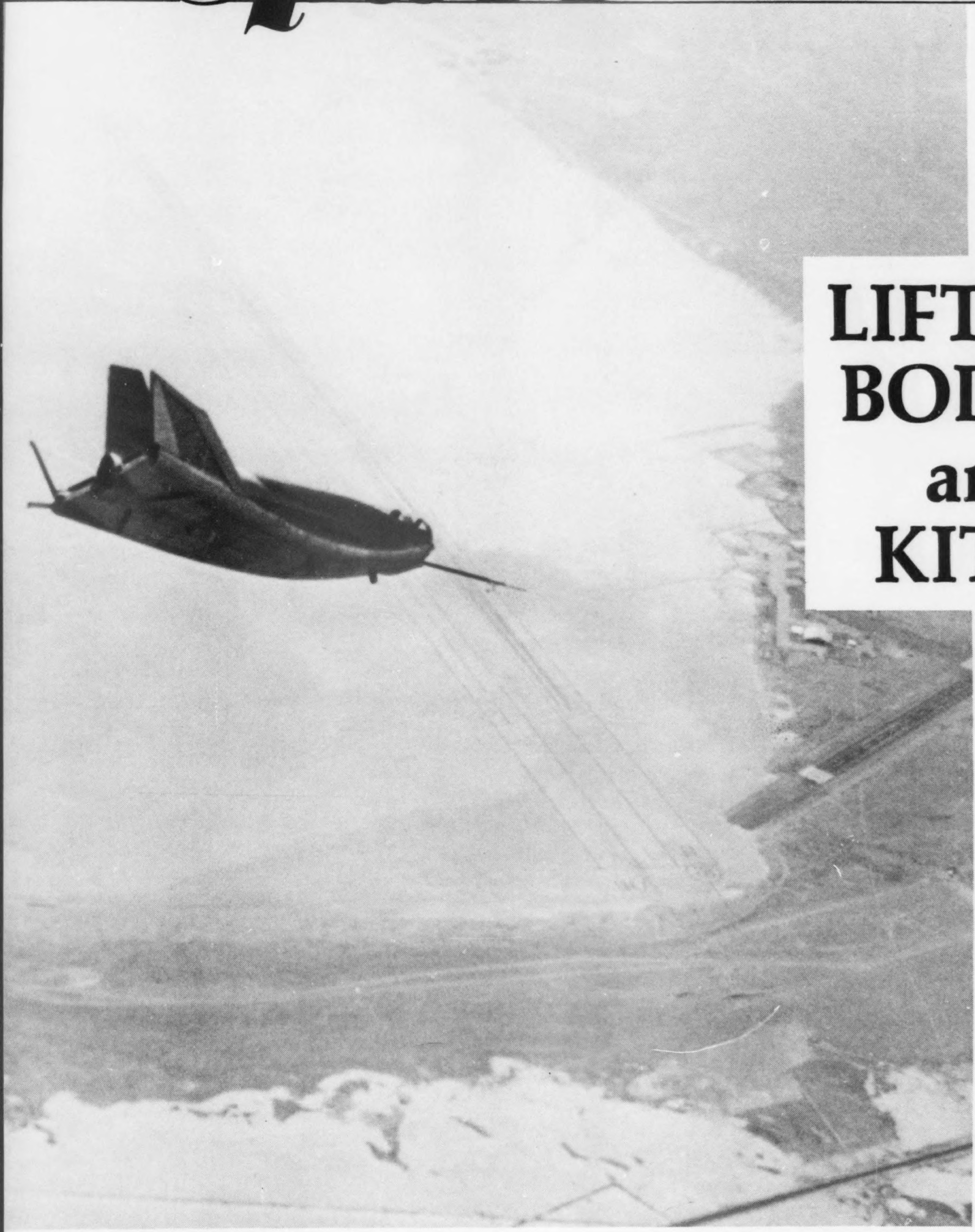
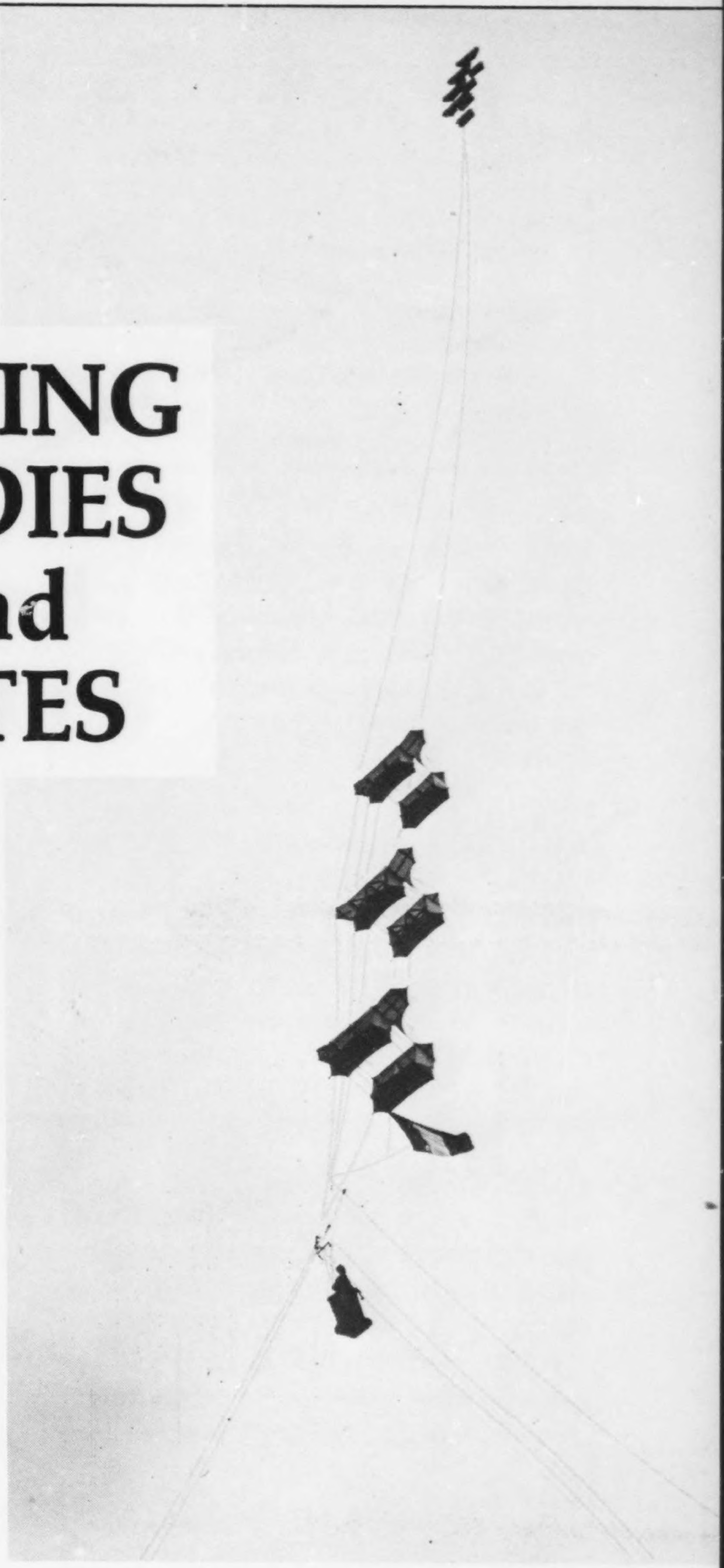
Air & Space

National Air & Space Museum
Smithsonian Institution

Vol. 3, No. 4 Mar.-Apr. 1980



LIFTING BODIES and KITES



Lifting bodies and kites represent two extremes of aerodynamic development not wholly unrelated. A lifting body is a wingless craft that achieves its aerodynamic lift from its body shape. Experimental lifting bodies were developed to test the concept of a reusable spacecraft capable of gliding back to Earth. The NASA-Northrop HL-10 (above left) was typical of the lifting bodies test-flown during the 1960s and '70s. Air-launched from a B-52 bomber at about 13,000 meters (45,000 feet), the HL-10 glided to a 270-320 kilometers per hour (170-200 miles per hour) touchdown at Dryden Flight Research Center, Edwards, Calif., in just 4 minutes.

The Space Shuttle (a winged vehicle), now scheduled for launch in the early 1980s, incorporates lifting body principles, building upon more than 40 years of research into the concept. More on lifting bodies, page 10.

Kites—delicate, ancient in lineage, necessarily tethered to the Earth from which their builders flew them—were mankind's first aircraft. But by the 19th Century (and possibly centuries earlier), kites were pulling men, women, and children into the sky. Above right, a train of Cody kites (invented by American expatriate Samuel F. Cody) lifts a man above England in the early 1900s. The ascent was part of a demonstration to show the value of man-lifting kites for raising military observers. Research by 19th-Century experimenters flying kites also helped lay the foundations of the science of aerodynamics that led to the successful development of the airplane. More on kites, page 3.

SCAN

For brevity, the National Air and Space Museum is often referred to in these pages as NASM. The National Aeronautics and Space Administration is NASA.

Air & Space, a mini-magazine for educators, is published every other month, September through May, as an outreach of the National Air and Space Museum, Smithsonian Institution, Washington, DC.

Air & Space combines information from many sources for a condensed overview of the history, science, technology, and social impact of selected aviation and space subjects.

MUSEUM HOURS
Until March 31, the Museum will be open from 10 a.m. until 5:30 p.m.; from April 1 through Labor Day (September 1), Museum hours will be 10 a.m. to 9 p.m. The Museum is open to the public every day of the year except Christmas.

FREE ASTRONOMY LECTURES FOR SCHOOL GROUPS
NASM's Albert Einstein Spacearium presents "Exploring Stars and Planets" lectures to school groups on Wednesdays from 11:30 a.m. to noon. These lectures are free, but are by appointment only. If you are planning a class trip to NASM, call (202) 381-4056 to make reservations for this presentation.

PHOTOCOPYING PAGES
Air & Space may be freely photocopied for classroom use. Commercial interests and other publications wishing to reprint material should mail request (address on back cover).

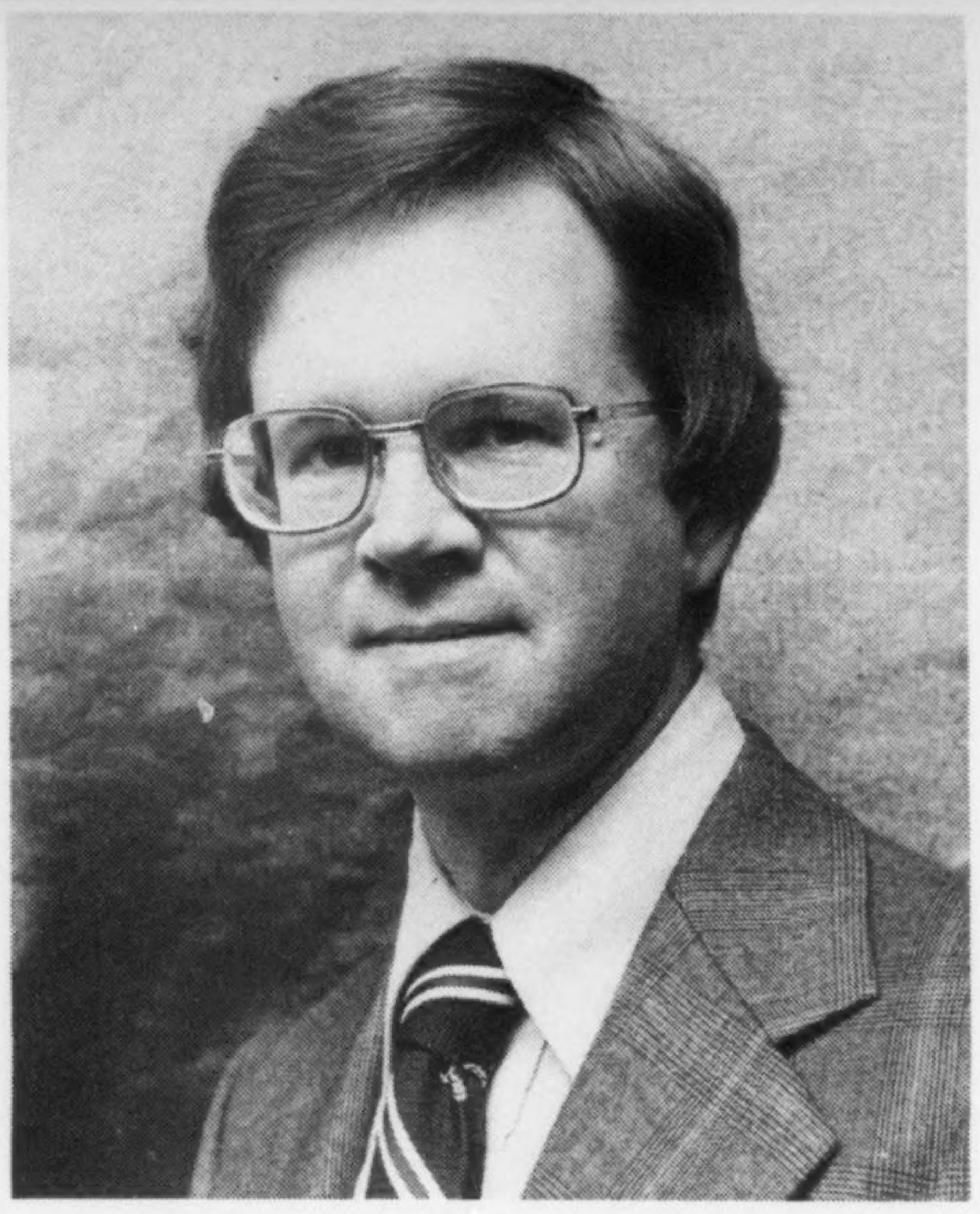
Air & Space Registration

Current recipients of *Air & Space* are registered for the coming school year. For changes or corrections of address, please send the mailing label or the coded information at the top of the label, along with the new address, to *Air & Space*, Room 3569, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560. Readers receiving unwanted duplicates should return the unwanted label.

In view of financial limitations, Air & Space **is not accepting any new registrations at this time.**

Back issues of *Air & Space* are available on microfiche through University Microfilms International, Inc., 300 N. Zeeb Road, Ann Arbor, MI 48106.

Briefing



Noel W. Hinners
Director, NASM

In this issue, *Air & Space* brings home a number of points regarding the differing fates of historical developments. The unusually lengthy history of kite-flying—probably the longest of any branch of aviation—is an example of an activity that has been (and is) conducted primarily for fun. Although experimenters flying kites have made some genuine contributions to aeronautics, kite-flying survives in essentially unaltered form today.

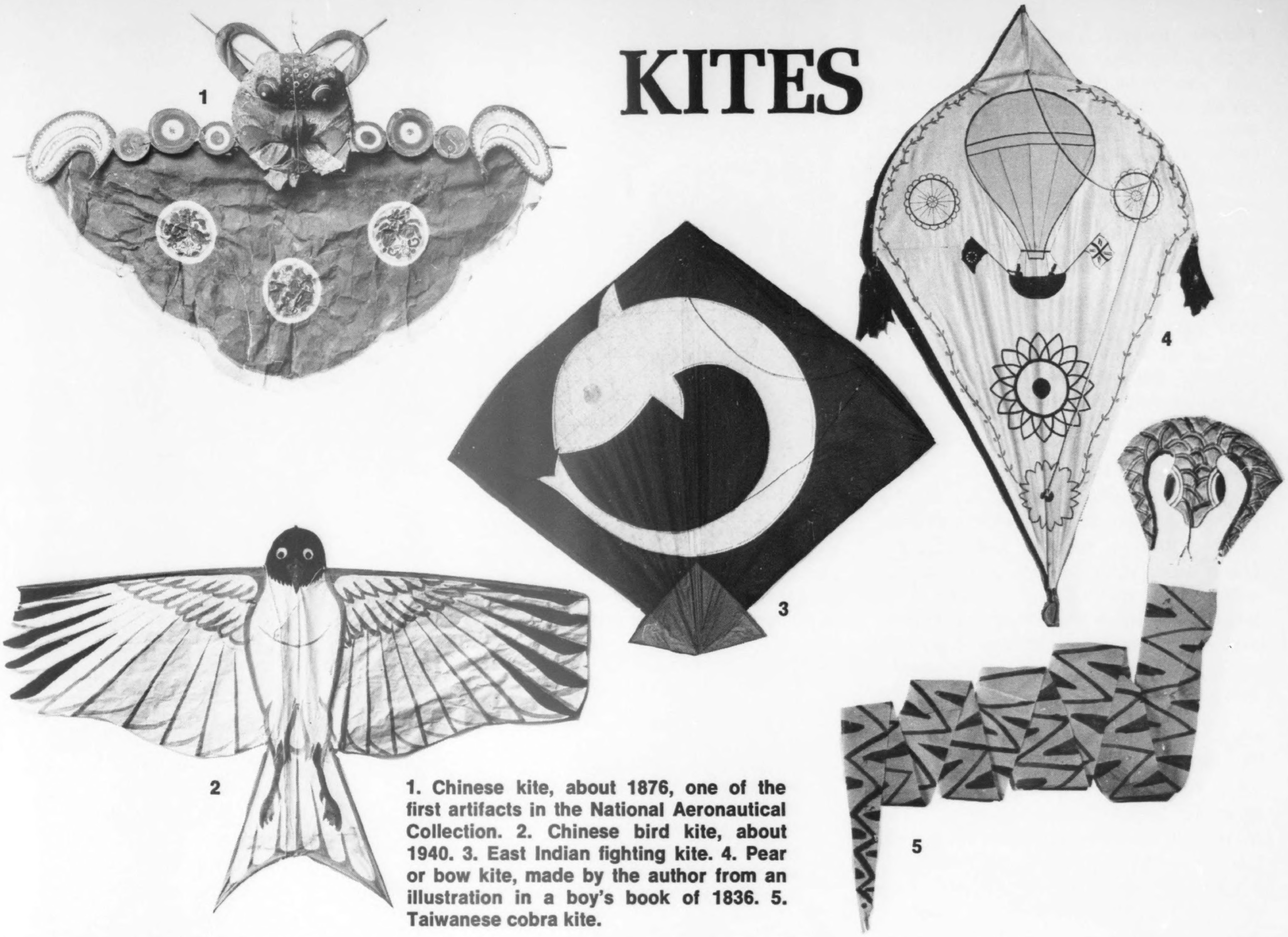
In great contrast, the development of lifting bodies has a short history during which a number of experimental programs were conducted to find out "how to do it," and to add empirical data to the existing body of knowledge in order to expand the theoretical understanding from which solid engineering design could proceed. The volumes upon volumes of data gathered from these programs, and the interpretation of that data, are much more significant than the setting of speed or altitude records *per se*. In fact, most of you will not have heard of some of the lifting body research vehicles, but without them—and there were those at the time who asked, "What good are they?"—there would be no Space Shuttle program underway today.

The story of U.S. women in aviation is fascinating, but makes one wonder. I'm talking about the fact that aeronautics in U.S. industry and government historically, with few exceptions, has been a male domain. Only in the last couple of years have women become commercial airline pilots. Quite clearly, since the beginning of aviation there were women who could fly as well as any man and who could get their hands dirty working on an oily engine.

Our coming Spacearium show connotes two things not widely known: First, that much of today's astronomy no longer is conducted from ground-based telescopes, but from satellites orbiting above the obscuring atmosphere. Enabling us to see some things more clearly, our "new eyes" also see things that are completely invisible from the surface of the Earth. Examples of these invisible bodies include x-ray objects, one of which may be caused by a mystical black hole, detectable only by its effect on some other, nearby object. The second point is that, because of the space-based nature of astronomy and the existence of our planetarium, we feel a need and desire to add astronomy as an area of historical and scientific study to the other programs of the National Air and Space Museum. I think that soon you'll see more feature articles on astronomy in *Air & Space* magazine.

It is tempting to ask, when you see an article on something as unusual as planetary toponymy, "Who cares?" Right now, mainly researchers studying lunar and planetary geology; someday, you, when you go to Mars or the Moon. Don't you think that it will be more practical and, yes, romantic to say to your pilot, "Take me to Olympus Mons," rather than, "17° North latitude and 134° longitude"?

KITES



1. Chinese kite, about 1876, one of the first artifacts in the National Aeronautical Collection. 2. Chinese bird kite, about 1940. 3. East Indian fighting kite. 4. Pear or bow kite, made by the author from an illustration in a boy's book of 1836. 5. Taiwanese cobra kite.

Kites come in myriad shapes, sizes, and designs—and kite fliers of all ages bring them to fly at the Smithsonian Institution's annual Kite Carnival, held in March on the Washington Monument grounds in Washington, D.C.

by Paul E. Garber
Historian Emeritus and Ramsey Fellow
Department of Aeronautics, NASM

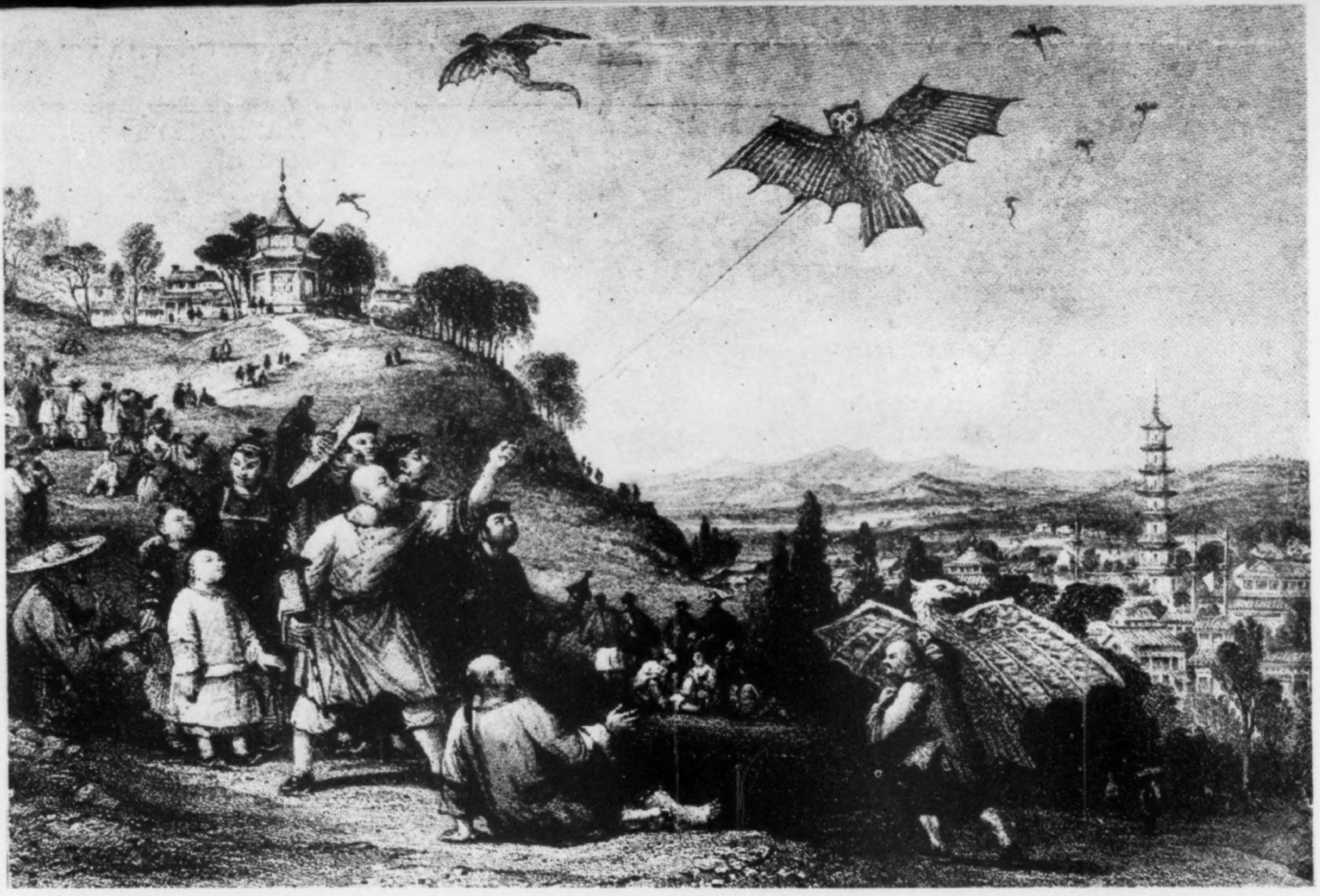
Kites were the first aircraft made by man—probably in China, about 3000 years ago. Since then, skill in making and flying kites has been developed to a high degree in the Orient. The first kites in Europe probably were Oriental types brought home by returning mariners. At first, Europeans did not apply their skills to making ornate kites, so the first kites made in Europe and the United States had simple shapes.

In 1752, Benjamin Franklin wanted to learn whether natural electricity (lightning) was similar to man-made electricity produced by friction or chemical means, so he made a square kite from a large silk handkerchief and two sticks attached diagonally from corner to corner. The vertical stick had a metal spike extending upward from the top to attract lightning.

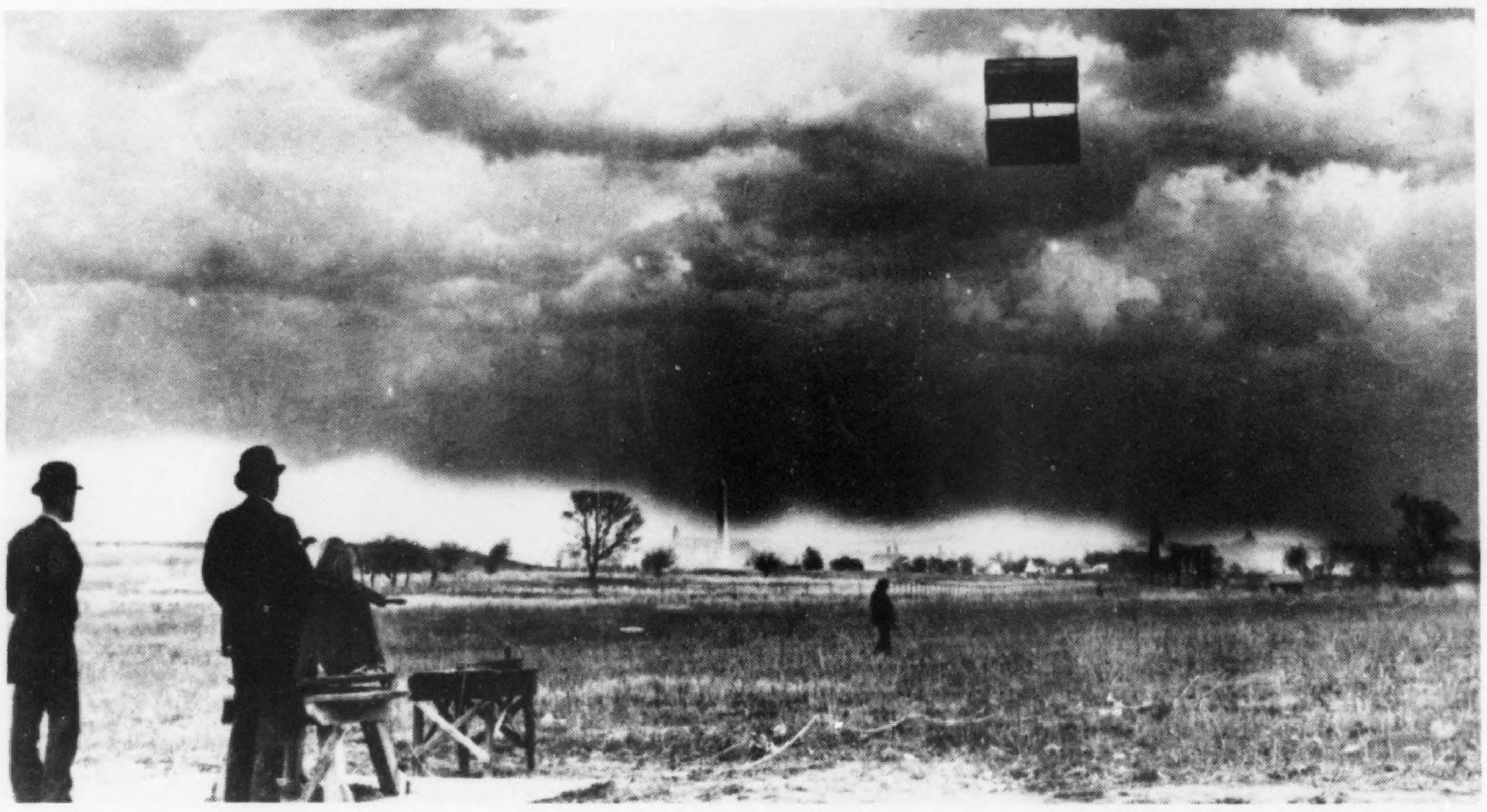
Franklin knew lightning was dangerous, and that a wet line would conduct electricity, so he did not hold the line in his hand. Franklin tied a large key to the end of the line, and in one hand held a dry silk ribbon tied to the key. As the lightning became more intense, the fibers of the line began to bristle. Holding his other hand close to the key, Franklin was thrilled when a spark jumped from the key to his knuckle. When the knob of a Leyden jar, an early type of electrical condenser, was held close to the key, sparks jumped across to it. Afterward, electrical experiments could be conducted with that jar, just as with those charged with man-made electricity.

Franklin's famous experiment was not the first time a kite was used for science. In 1749, in a meteorological experiment, Alexander Wilson and Thomas Melville attached thermometers to kites and flew them to high altitudes above Scotland. The thermometers were released by a burning fuse. Bushy tails attached to the instruments slowed their descent. The thermometers showed temperatures at higher altitudes to be colder than those at ground level.

During the 19th Century, a number of experimenters in aeronautics used kites for testing their ideas. Sir George Cayley developed a wide-winged kite to test the relationship between center of gravity and center of pressure on a lifting surface. Alphonse Penaud of



Above: The kite probably was invented in China, perhaps 3000 years ago; this Chinese print depicts a well-attended kite festival. Below: Launching a U.S. Weather Bureau kite from the Potter farm in Arlington, Va., about 1910. Samuel Potter designed large box kites for raising meteorological instruments to altitudes of several miles to obtain information for weather forecasting.



France tested longitudinal stability with a kite that would fly without a tail. Lawrence Hargrave of Australia, trying to design a man-carrying airplane, developed a cellular kite, which in a square or rectangular form is called a box kite. The box kite was the ancestor of the biplane wing, and was adopted and modified by others who were experimenting with gliders and airplanes.

The Lilienthal brothers of Germany used kites to test their ideas for control of an aircraft. Octave Chanute of Chicago made cellular kites in various forms during his experiments with gliders. Samuel Pierpont Langley, third Secretary of the Smithsonian Institution, learned from his kites that a curved wing created more lift than a flat wing. In August 1899, Wilbur Wright flew a cellular kite that he could steer right or left, make climb or descend, and balance laterally. This kite represented the Wright brothers' first step toward achieving three-axis control, a prerequisite to the success of their 1903 Flyer.

Several experimenters succeeded in lifting human beings with kites. During the mid-1890s, Captain B. F. S. Baden-Powell experimented with man-raising kites in England, first using an 11-meter (36-foot) hexagonal kite, and later a series of several smaller kites. Baden-Powell's kite raised a man about 30 meters (98 feet) on numerous occasions.

Alexander Graham Bell, inventor of the telephone, was a very active experimenter with kites. One of Bell's tetrahedral kites having 3393 cells raised U.S. Army Lt. Thomas Selfridge nearly 60 meters (197 feet) in 1907.

In England, American expatriate Samuel F. Cody developed huge cellular kites with extended wings. In the early 1900s, a train of these—i.e., several kites flown one above another—raised a military observer a few thousand meters (several thousand feet).

Marconi's first transatlantic radio message was sent from Ireland in 1901 and received in Newfoundland, where the antenna was held aloft by a large kite. As a result of this demonstration, armies and navies throughout the world added kites to their radio equipment. During World War II, U.S. pilots' emergency equipment included a kite and a radio that could send signals to direct rescuers to a downed flier.

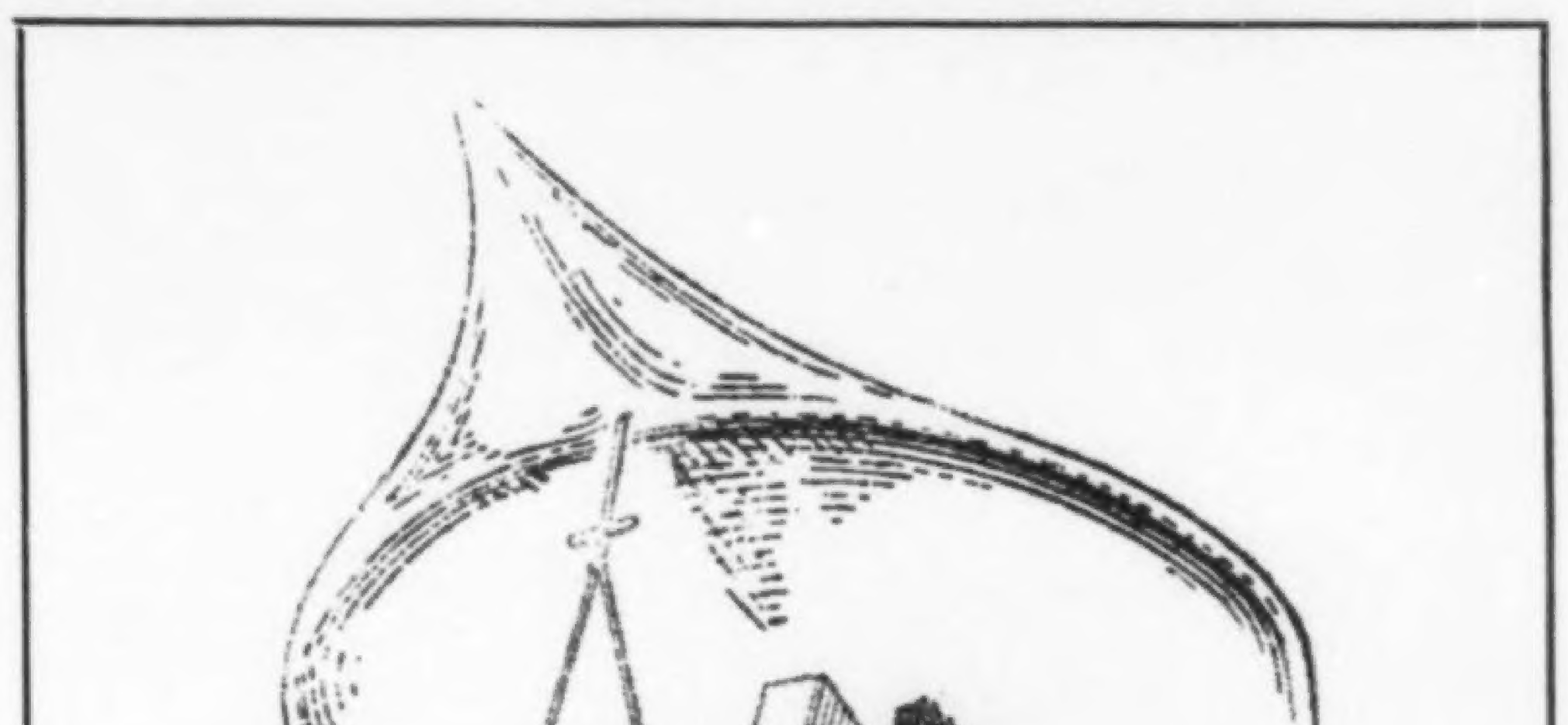
The use of kites in warfare dates back to early Oriental conflicts, when they were used for signalling, raising observers, and elevating whistles and lights at night to frighten an enemy. In later wars, kites have been flown over enemy lines to drop messages to frighten or influence enemy soldiers.

In 1911, Samuel Perkins of Boston demonstrated to the U.S. Navy that a train of his kites could raise an observer much higher than the tops of the masts then used on Navy battleships. During both World Wars, the Germans used man-lifting kites for raising observers from submarines.

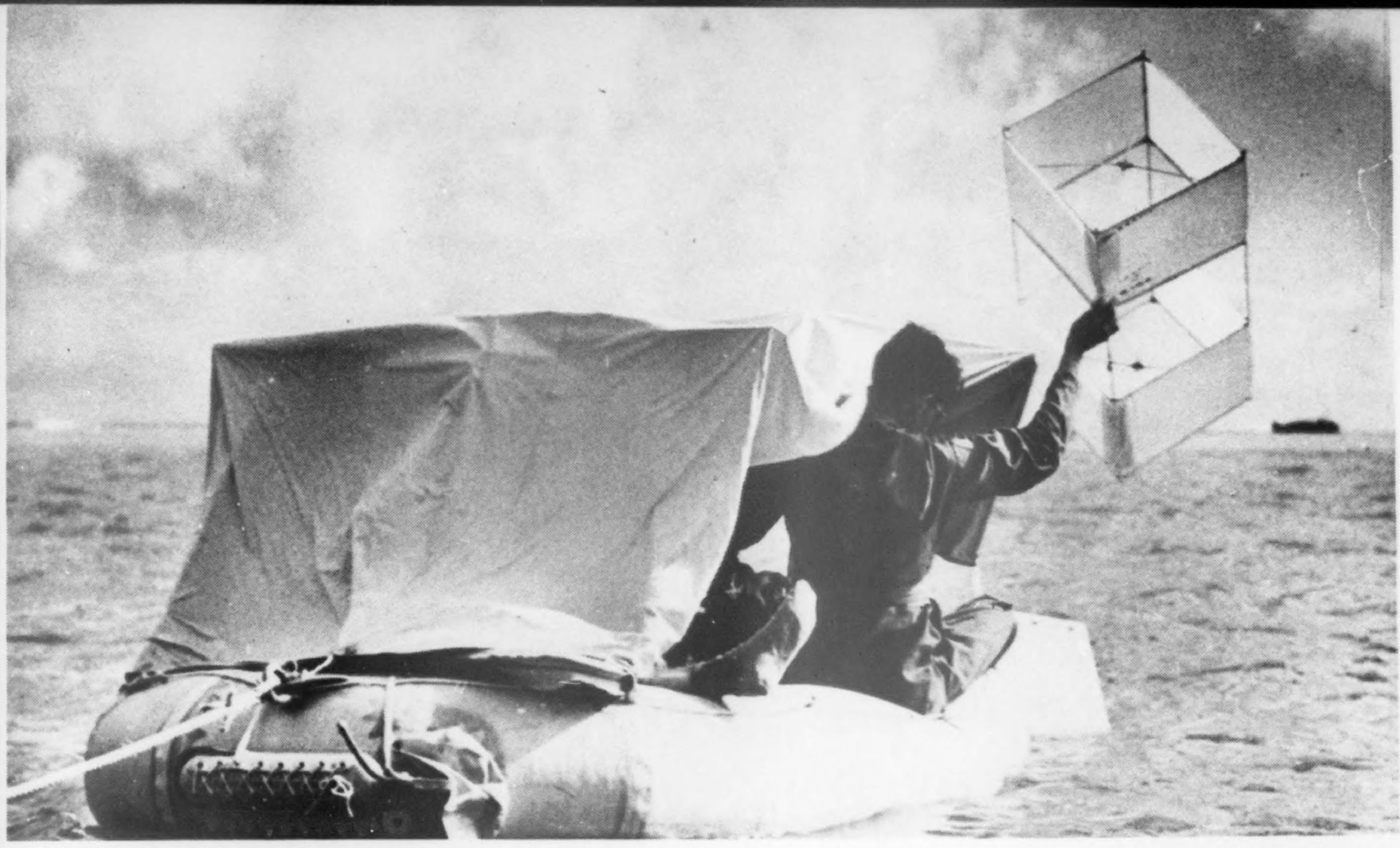
During my World War II service in the U.S. Navy, I invented a maneuverable target kite for ship-to-air gunnery practice. Many thousands were distributed to all ships and stations. I was then assigned to the development of a kite-supported system whereby mail, charts, and other material could be airlifted from a ship at sea to an airplane and rushed to the place of need.

I also worked on a kite-lifted aerial camera project, but this was not a new idea. Kites had been used to loft cameras since 1889. During the Spanish-American War, William Eddy assembled a kite-and-camera apparatus intended to take pictures of enemy harbors.

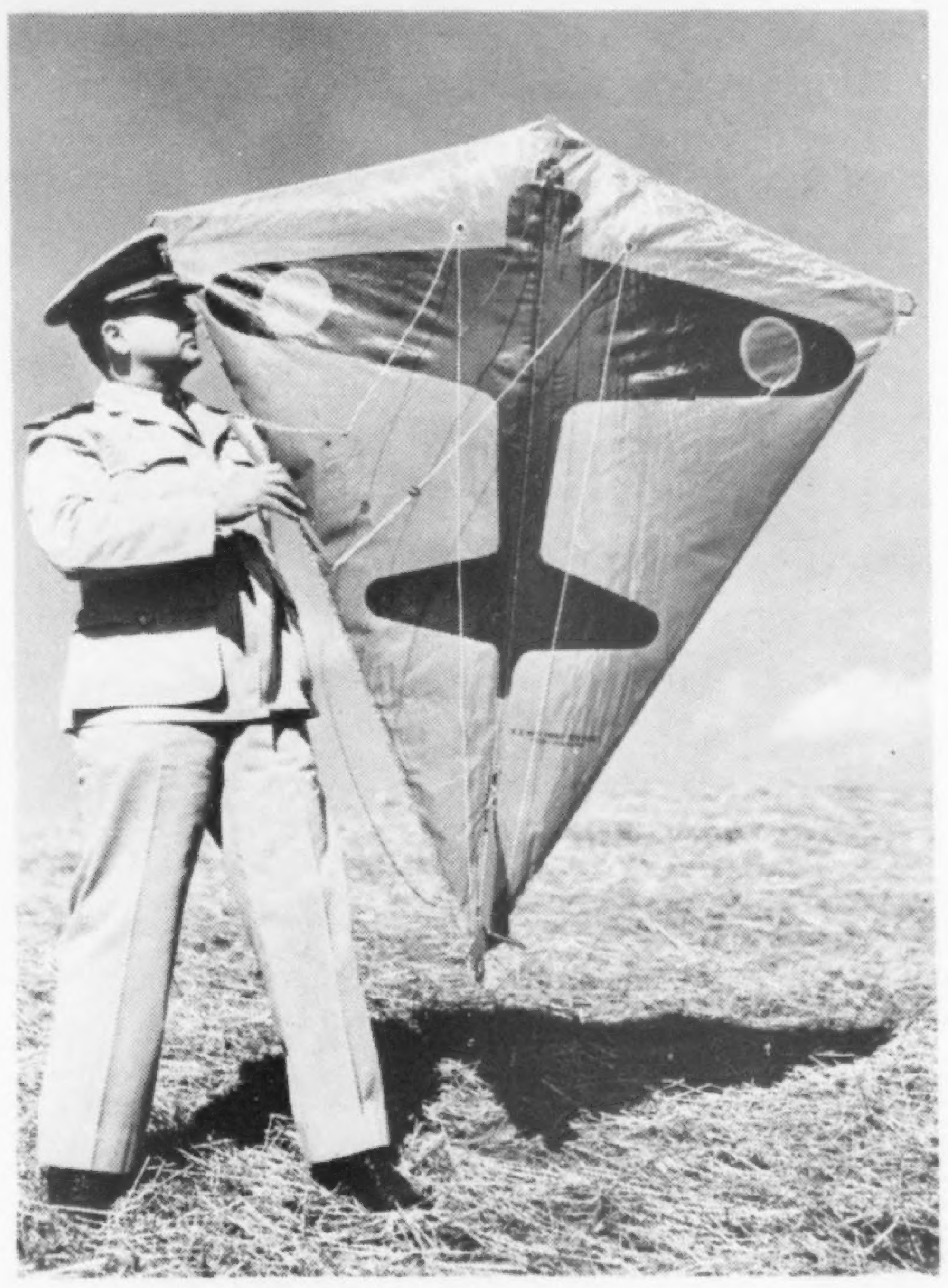
Prior to that war, Eddy had worked with the Blue Hill Observatory in



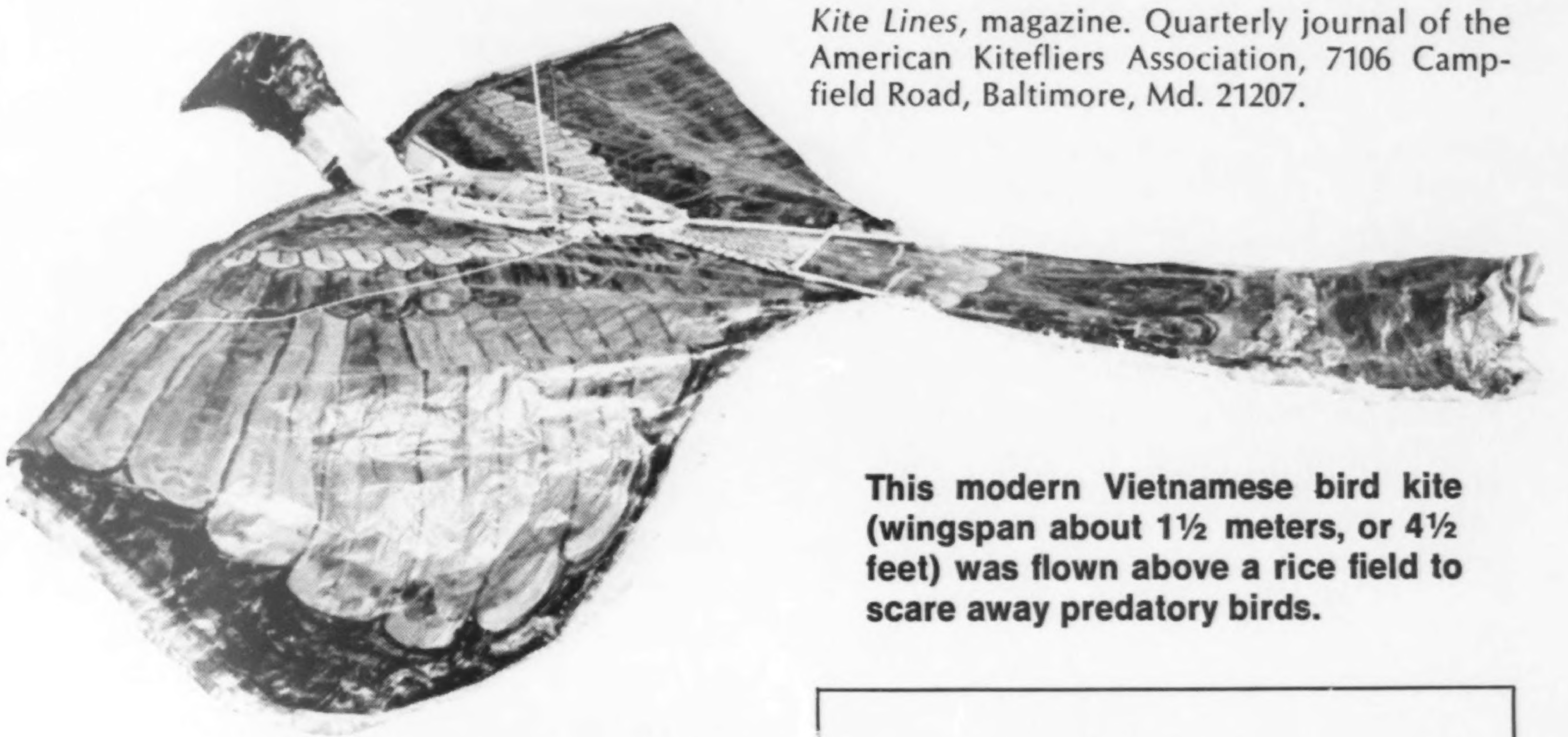
Photographers have used kites since 1889, when Frenchman Arthur Batut flew a homemade box camera on a diamond-shaped kite. This early model used a pear or bow kite.



Above: **Part of the survival equipment issued to U.S. Army and Navy pilots during World War II was the "Gibson Girl" box kite, so named because it came in a container that was narrow-waisted like the young women drawn by popular cartoonist Charles Dana Gibson. The kite raised an antenna wire for an emergency radio.**



The author during World War II with the target kite he invented while a U.S. Navy Commander. Thousands of these target kites were used for ship-to-air gunnery practice.



This modern Vietnamese bird kite (wingspan about 1½ meters, or 4½ feet) was flown above a rice field to scare away predatory birds.

Massachusetts, where his kites (as well as modified Hargrave box kites) raised instruments to high altitudes to determine conditions that affected the weather. In 1910, a train of Eddy kites established an altitude record of about 7.2 kilometers (4.5 miles). Beginning in the 1890s, the U.S. Weather Bureau used kites to raise instruments for weather forecasting. Their use continued until the wires with which the kites were tethered were foreseen to be a possible hazard to airplanes.

Kites also have a special importance for the National Air and Space Museum. Spencer Baird, the second Secretary of the Smithsonian Institution, visited the Centennial Exposition held in Philadelphia in 1876; after it closed, he obtained many of the exhibits for the Smithsonian Institution. Included was a collection of kites that had adorned the Imperial Chinese display. Those kites, the first aeronautical objects received by the Smithsonian, formed the nucleus of the vast collections that are preserved and exhibited by NASM today. A selection of those kites is on display in NASM's Flying for Fun gallery and at our facility in Silver Hill, Md.

Our interest in kites led to our planning and conducting an annual Smithsonian Kite Carnival, which includes a display of kites; a lecture on their history, types, and how to make and fly them; and a workshop in which participants are assisted in making kites. The Kite Carnival culminates in a glorious day on the Washington Monument grounds, where everyone tries to fly his or her homemade kite, and ribbons and trophies are awarded for appearance and performance. Although not everyone can win a trophy, all can savor the pleasure of following the old epithet to "go fly a kite."

Readings

Kites, An Historical Survey, Clive Hart. New York: Praeger, printed in Great Britain, 1967.

Your Book of Kites, Clive Hart. London: Faber & Faber, 1964.

Kites, World Book Encyclopedia. Chicago: Field Enterprises.

Chinese Kites, David F. Jue. Rutland, Vt.: Charles E. Tuttle, 1967.

The Penguin Book of Kites, David Pelham. New York: Penguin Books, 1976.

Kites and Kite Flying, Will Yolen. New York: Simon and Schuster, 1976.

Kites, Wyatt Brummitt. New York: Golden Press, Western Publishing Co., 1971.

The Art of the Japanese Kite, Tal Streeter. New York: Weatherhill, 1974.

World on a String, Jane Yolen. New York: World Publishing Co., 1968.

High Fliers, Colorful Kites from Japan, Tadao Saito. Tokyo: Japan Publications, 1969.

Kite Craft, Lee Scott Newman and Jay Hartley Newman. New York: Crown Publishers, 1974.

Kite Lines, magazine. Quarterly journal of the American Kitefliers Association, 7106 Campfield Road, Baltimore, Md. 21207.

Kite Flier's Code

I will fly kites in an open field, away from electric power wires or transmission towers.

I will use perfectly dry string—never wire.

I will not try to remove a kite if it catches in an electric power wire or on a high pole.

I will not use any metal in making a kite.

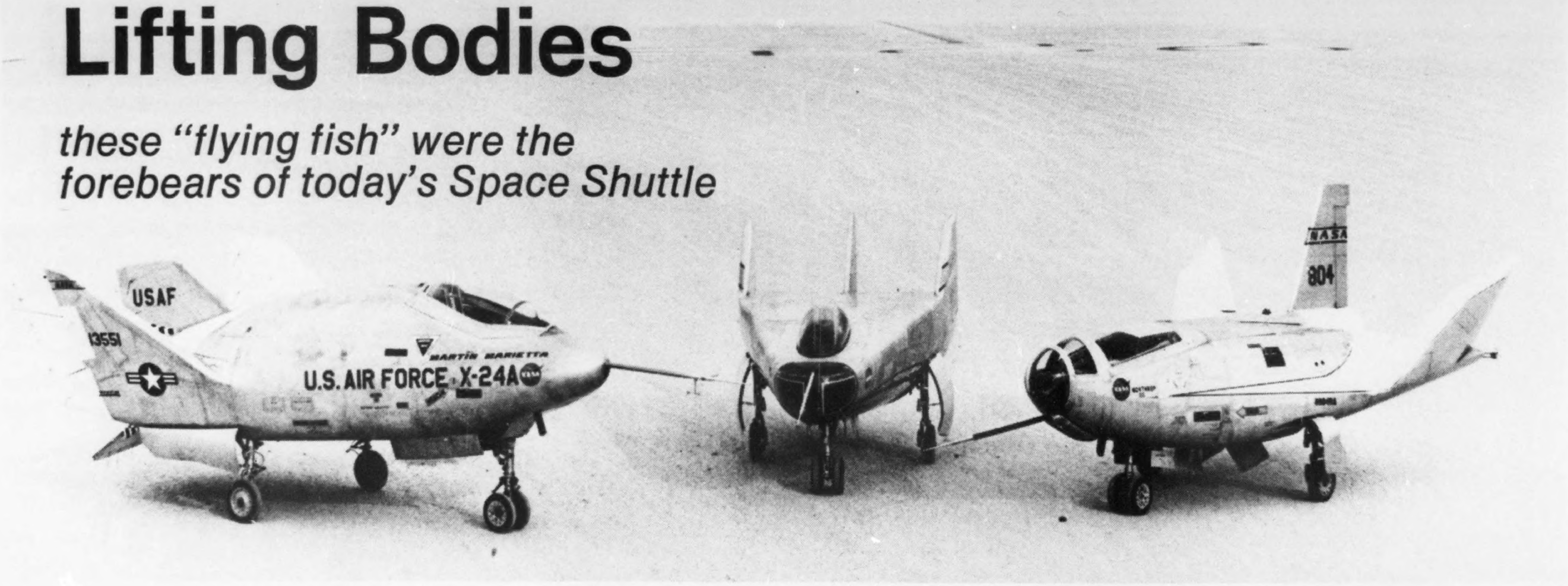
I will not fly kites on or near a public highway.

I will never fly a kite in wet or stormy weather.

I will have fun flying a kite and be safe, too.

Lifting Bodies

these "flying fish" were the forebears of today's Space Shuttle



These manned wingless lifting bodies (from left to right, the Martin Marietta X-24A, the Northrop M2-F3, and the Northrop HL-10), photographed in January 1970 at the NASA Flight Research Center, Edwards, Calif., were among several research craft flight-tested as possible low-speed predecessors of future space shuttle configurations.

by Richard P. Hallion
Curator
Department of Space Science and Exploration, NASM

When the NASA Space Shuttle *Columbia* roars into orbit sometime in the early 1980s, it will fulfill a dream of half a century: the development of reusable manned spacecraft that can land like conventional airplanes. The concept of a shuttle flying into Earth orbit, performing some task (such as resupplying an orbiting space station or placing a satellite in orbit), then winging back to land, can be found in the writings of such early 20th-Century astronautical pioneers as Konstantin Tsiolkovsky, Robert Goddard, Hermann Oberth, Max Valier, and Walter Hohmann.

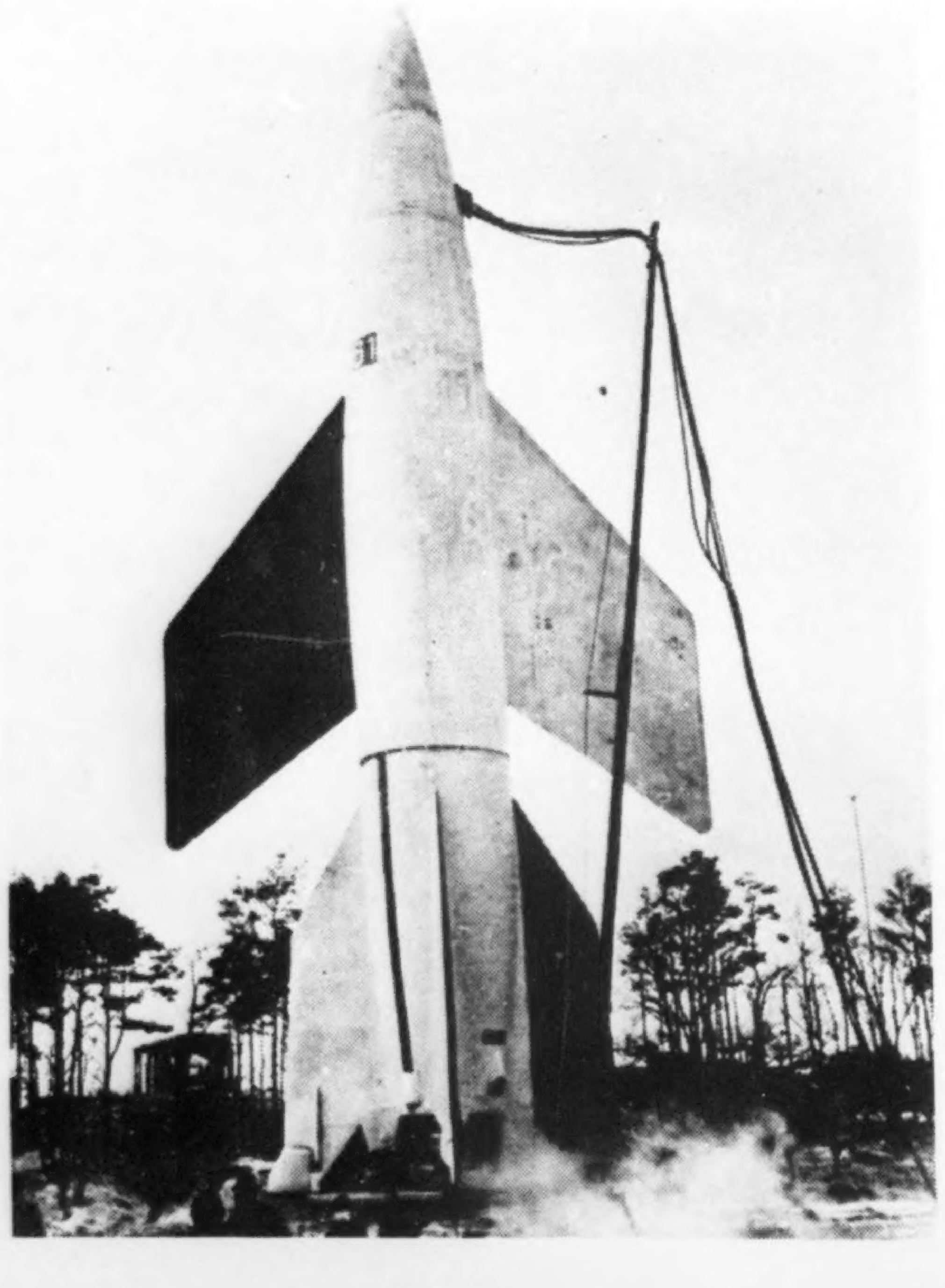
Such conceptions received a definite push forward during the 1930s, when Austrian Eugen Sänger and Irene Bredt postulated a "Rocket Spaceplane" shaped like a winged laundry iron, capable of attaining Earth orbit. The sled-launched Sänger-Bredt spacecraft concept greatly influenced post-World War II research on winged lifting reentry spacecraft. During World War II, German technologists at Peenemünde developed an experimental lifting reentry vehicle, the A-4b (a modified version of the V-2 rocket), firing it with partial success in early 1945.

After the war, studies by the National Advisory Committee for Aeronautics (NACA, predecessor to today's NASA) on the problems of aerodynamic heating during reentry led to the blunt body concept. Pioneered by scientist H. Julian Allen at Ames Aeronautical Laboratory, this principle was used on the Mercury, Gemini, and Apollo spacecraft. However, researchers sought greater control and maneuverability during the spacecraft's reentry, plus lifting characteristics that would permit flexibility in choosing a landing site. These goals led to studies of radical *winged* spacecraft capable of reentering the Earth's atmosphere at speeds approaching Mach 25 (25 times the speed of sound), and then gliding to a landing.

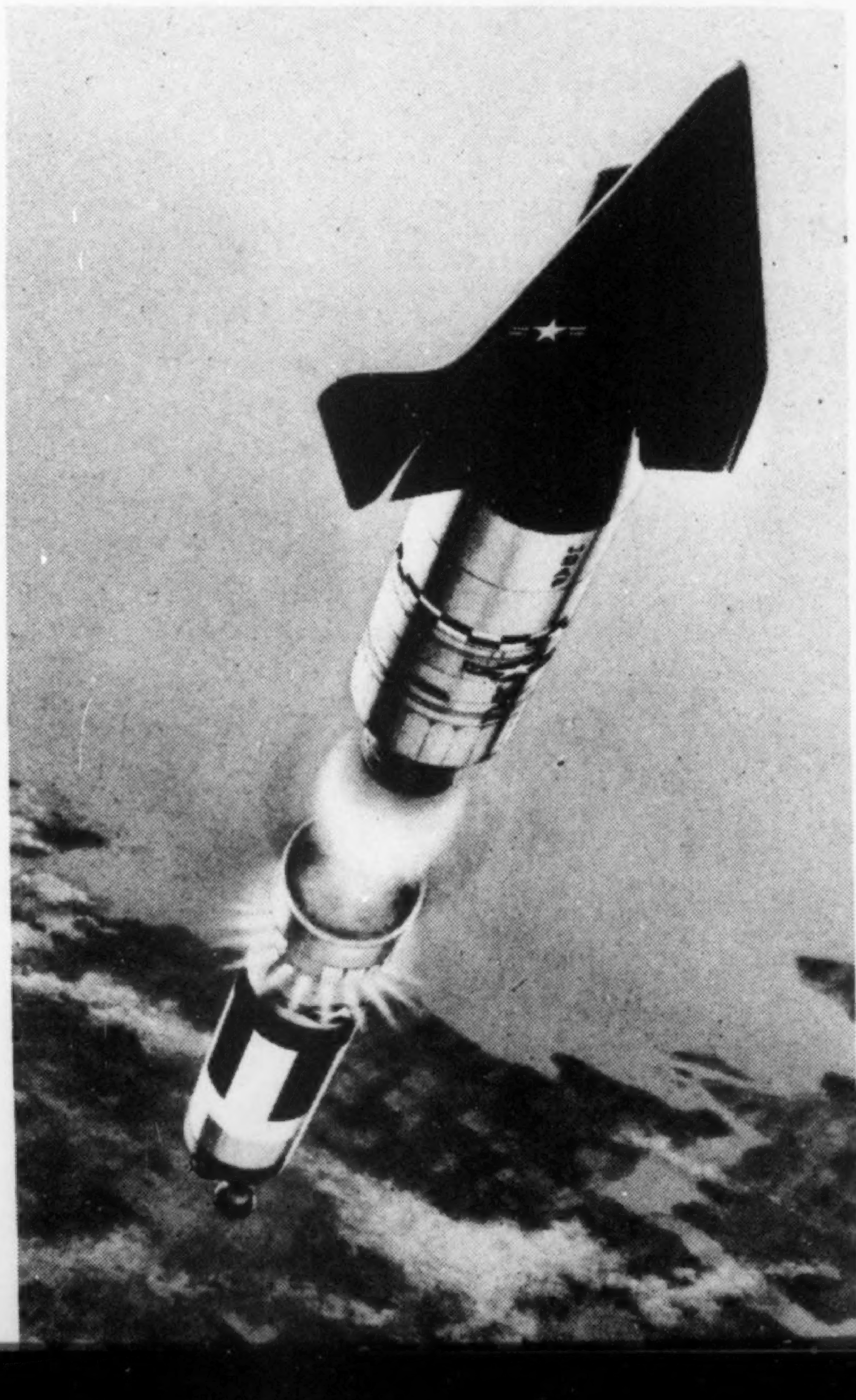
In October 1957, this work crystallized in the Air Force's Project Dyna-Soar (for *Dyna*mic *Soar*ing), a consolidation of three earlier research projects. Project Dyna-Soar's Boeing X-20A was a slender delta designed for launch by a modified Martin Titan II (and later Titan III) booster. This piloted spacecraft would have had an exotic superalloy structure, used radiative cooling techniques, and would have landed on retractable wire brush skids. A lack of program definition and increasing controversy over its merits led to its cancellation at the end of 1963.

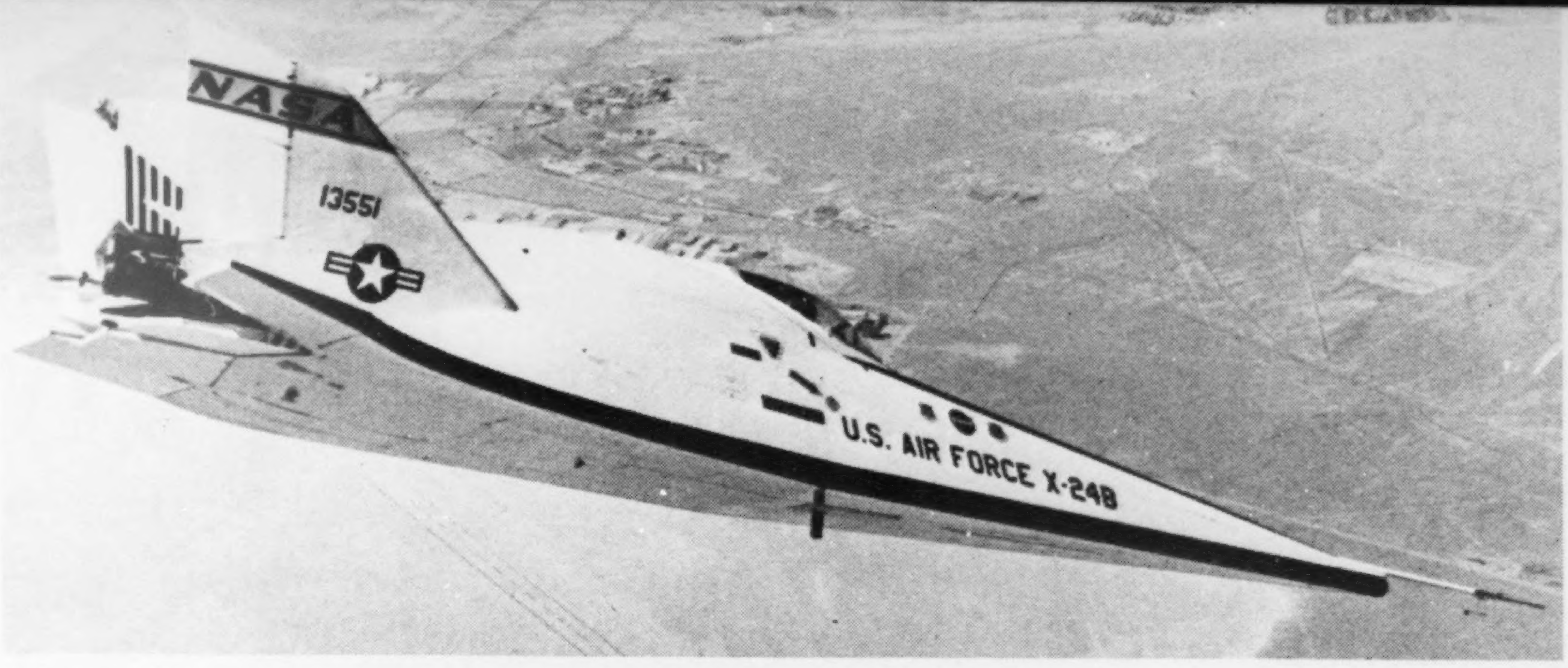
In the interim, research continued on model winged research craft and modified blunt body shapes, termed lifting bodies, that could generate modest lift and yet provide adequate thermal protection to the spacecraft during return from orbit.

The ASSET, START, and PRIME programs demonstrated that winged and lifting body spacecraft could successfully reenter Earth's atmosphere from space. The PRIME project, using Martin SV-5D testbeds, showed the feasibility of maneuvering lifting body spacecraft during reentry at hypersonic speeds (five or more times the speed of sound). Concern over the low-

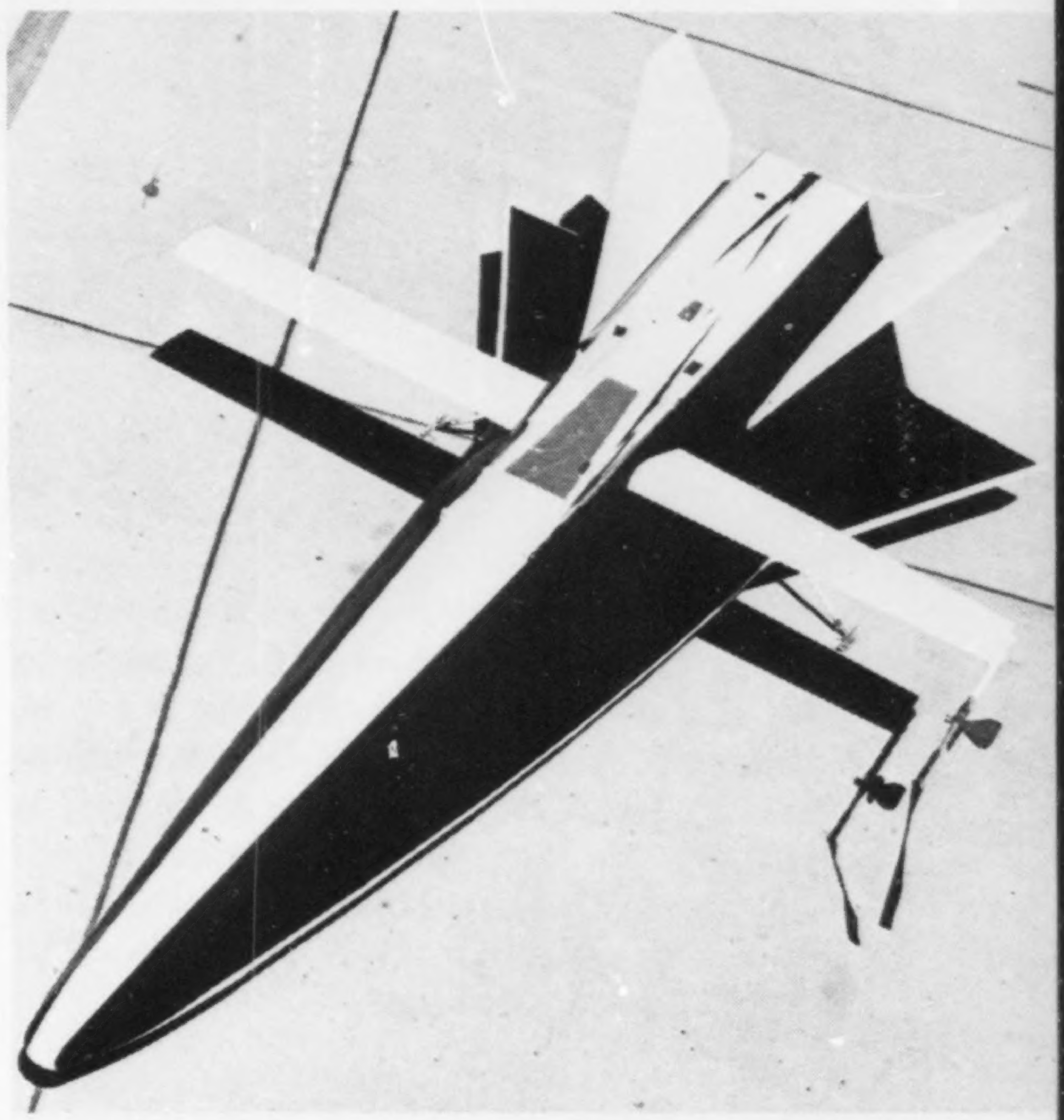


Left: The A-4b, one of the first experimental lifting reentry vehicles, was developed from the V-2 rocket during World War II by German technologists. The A-4b was fired with partial success in 1945. A V-2 is on display in NASM's Space Hall. Right: An artist's concept of the U.S. Air Force's Project Dyna-Soar, a piloted Boeing X-20A winged spacecraft designed for launch by a modified Martin Titan II booster rocket. Project Dyna-Soar was cancelled in 1963.





Above: When the U.S. Air Force/NASA X-24B made its last flight (Sept. 23, 1975), it was the only rocket-powered aircraft still in operation. Right: Hyper III was a remotely piloted research vehicle (RPRV) designed to test the concept of hypersonic reentry from space, followed by deployment of "switchblade" wings for landing like a conventional airplane.



speed handling qualities of lifting body shapes led to the construction of small manned research craft, test-flown at the NASA Flight Research Center (now the Dryden Flight Research Center) at Edwards, Calif. These craft—the NASA M2-F1, the Northrop M2-F2/M2-F3, the Northrop HL-10, and the Martin X-24A/X-24B—proved that lifting bodies could complete unpowered descents, approaches, and landings in a manner similar to the hypersonic North American X-15.

The National Air and Space Museum includes within its collections the Northrop M2-F3 lifting body. This craft originally was built by Northrop as the M2-F2 in June 1965, and made its initial flight (dropped from a B-52 launch aircraft) on June 12, 1966. On May 10, 1967, the craft crashed during a landing on Rogers Dry Lake, Calif., severely injuring the pilot, Bruce Peterson. The M2-F2 was badly damaged in the accident—it had rolled over six times before coming to rest—and for a while, NASA feared that the program would have to be terminated. However, a NASA-Northrop team rebuilt the craft with an additional vertical fin, and it emerged as the M2-F3. Following 27 research flights, including many at supersonic speeds up to 1712 kilometers (1064 miles) per hour, the M2-F3 was retired from flight research. Today it hangs in the Space Hall of the National Air and Space Museum.

During the 1960s, NASA, the Department of Defense, and private companies undertook a variety of studies on orbital space transportation vehicles utilizing ballistic or lifting reentry return. The concept of a fully (or nearly fully) reusable lifting reentry spacecraft with either a winged or lifting body configuration gradually superseded other schemes. Many novel design approaches appeared, including advanced lifting bodies, slender deltas, and craft having variable-geometry "switchblade" wings. Most were 2-stage vehicles having a winged pilotless booster and a piloted second stage that would go into orbit.

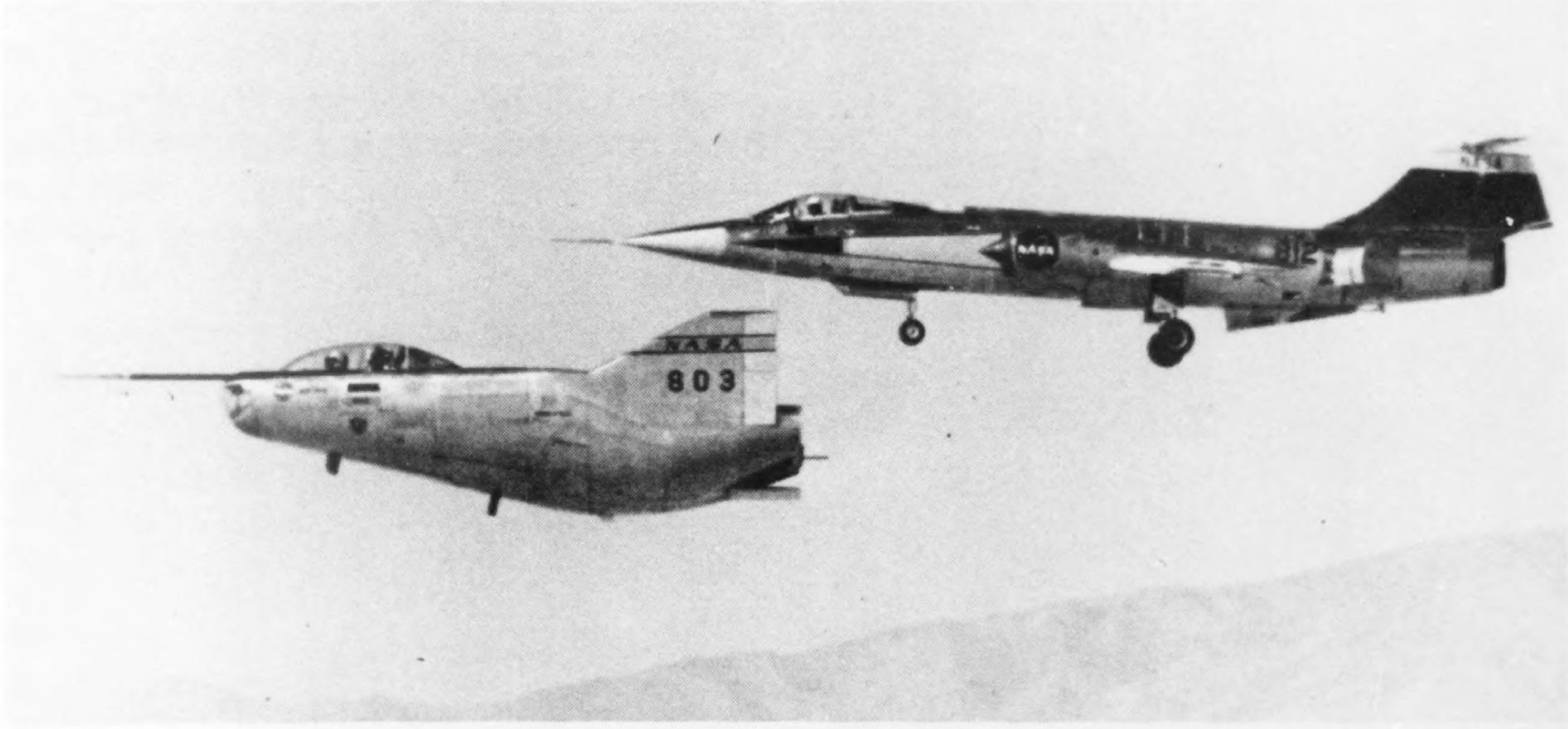
In February 1969, NASA awarded four Shuttle study contracts to Lockheed, General Dynamics, McDonnell-Douglas, and North American-Rockwell (later just Rockwell). Shortly afterwards, a report of NASA's Space Shuttle Task Group concluded that a Shuttle spacecraft could perform a variety of useful space missions, and termed it "the keystone to the success and growth of future space flight developments for the exploration and beneficial uses of near and far space."

In July 1970, NASA awarded advanced "Phase B" Shuttle study contracts to McDonnell-Douglas and Rockwell. Both companies studied fully reusable Shuttle configurations having two stages—a piloted first-stage booster, and a second-stage orbiter.

By this time, however, NASA's plans for the Shuttle were undergoing revision. Because of the post-Apollo contraction of the national space program, NASA was forced to abandon a planned orbital space station development program. The agency retained the Shuttle, whose mission now became one of replacing expendable boosters used in putting satellites and probes into space.

The reduction in NASA's budget placed the Shuttle in serious jeopardy. As a result, the agency had to drastically revise its estimates of the Shuttle program's cost, its objectives, and the actual configuration and capabilities of the vehicle itself. Following further studies, the agency decided to abandon the concept of a 2-stage fully reusable system having both a flyback booster and orbiter, and opted for a partially expendable system using just a fully reusable orbiter vehicle and two solid-fuel rocket boosters.

In January 1972, President Nixon endorsed development of the Shuttle, now termed the Space Transportation System. In March of that year, NASA decided to use a parallel-burn (as opposed to sequential-staging) launch system. On July 26, 1972, Rockwell received a final go-ahead to proceed with Shuttle development. Rockwell began fabrication of the first Shuttle, Orbiter OV-101 *Enterprise*, on June 4, 1974, completing it in September 1976. This craft underwent approach and landing tests at the Dryden Flight Center in 1977. Shuttle Orbiter OV-102 *Columbia* is being readied for its first flight in the near future.



The pilot of a NASA F-104 chase plane (right) keeps close watch on the Northrop M2-F2 lifting body (left) just prior to landing. On May 10, 1967, the M2-F2 crashed during a landing approach; NASA film of the accident later was used as a lead-in to a popular television series, "The Six Million Dollar Man." Rebuilt and flown as the M2-F3, the craft eventually was retired; today it hangs in NASM's Space Hall.

Above: One of the first U.S. women to pilot her own aircraft, balloonist Mary H. "Carlotta" Myers retired from exhibition work in 1891. Below: Bernetta Miller, a member of the Moisant International Aviators exhibition team, was the first person to demonstrate a monoplane to U.S. government officials.

Those Magnificent Women in their Flying Machines

U.S. women in aviation from 1880 through World War I

by Claudia M. Oakes
Assistant Curator
Department of Aeronautics, NASM

In the early days of the 20th Century, women in the United States who wanted to be pilots were all too familiar with the struggle of women for acceptance in traditionally all-male pursuits. Aviation on a world-wide basis, however, was not traditionally all-male. In Europe as early as 1834 there were 22 women who had piloted balloons. As aviation expanded to include heavier-than-air craft, it might have been expected that women, having been so active in the lighter-than-air era, would be just as active in the airplane age.

Unfortunately, this did not happen. It was considered radical for a woman to involve herself in any way in aviation, whether flying as a passenger in an airplane, ascending in a balloon, or just offering support to aviator sons, husbands, or brothers. In Philadelphia in 1909, for instance, a young socialite even attempted to conceal her identity when she finally satisfied her ambition to make a balloon flight. She feared that her family and friends would try to stop her.

One of the first women in the United States to pilot her own aircraft was Mary H. Myers of Mohawk, N.Y. Billed as "Carlotta, the Lady Aeronaut," she made her first solo balloon flight on July 4, 1880. Mrs. Myers had been assisting her husband, Carl, in his research in ballooning and air navigation, and became so interested that she took up ballooning herself. One of her most famous flights was over New York City—from Brooklyn to Jersey City—in 1890.

As the age of heavier-than-air craft began to eclipse that of ballooning, there were women who knew they could pilot airplanes as well as men. One of their main obstacles, however, was finding someone who would agree to teach them.

Glenn Curtiss, a noted pioneer of early aviation, was particularly adamant about not accepting women into his flying schools. However, Curtiss agreed to teach Blanche Stuart Scott, who became the first woman to solo in the United States. Ms. Scott had already gained fame in 1910 as the first woman to make a transcontinental automobile trip. She became interested in aviation during that trip when she passed through Dayton, Ohio, and saw the Wright Brothers' school.

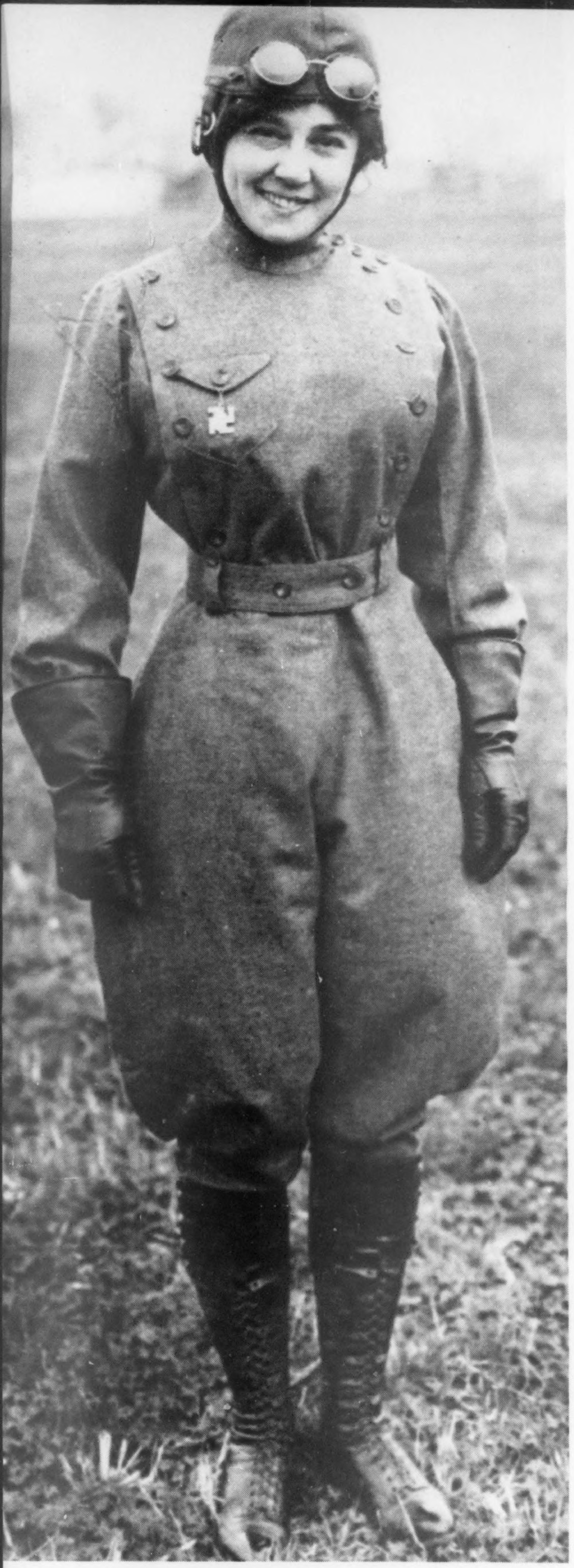
Curtiss took her on as his personal pupil, the only woman he ever taught, at his Keuka Lake field near Hammondsport, N.Y. To keep his student safely on the ground, Curtiss had blocked the throttle on the 35-horsepower pusher aircraft in which Ms. Scott was training. However, on Sept. 2, 1910, "something happened" to the throttle block, and to Curtiss' amazement, Ms. Scott rose about 12 meters (40 feet) into the air.

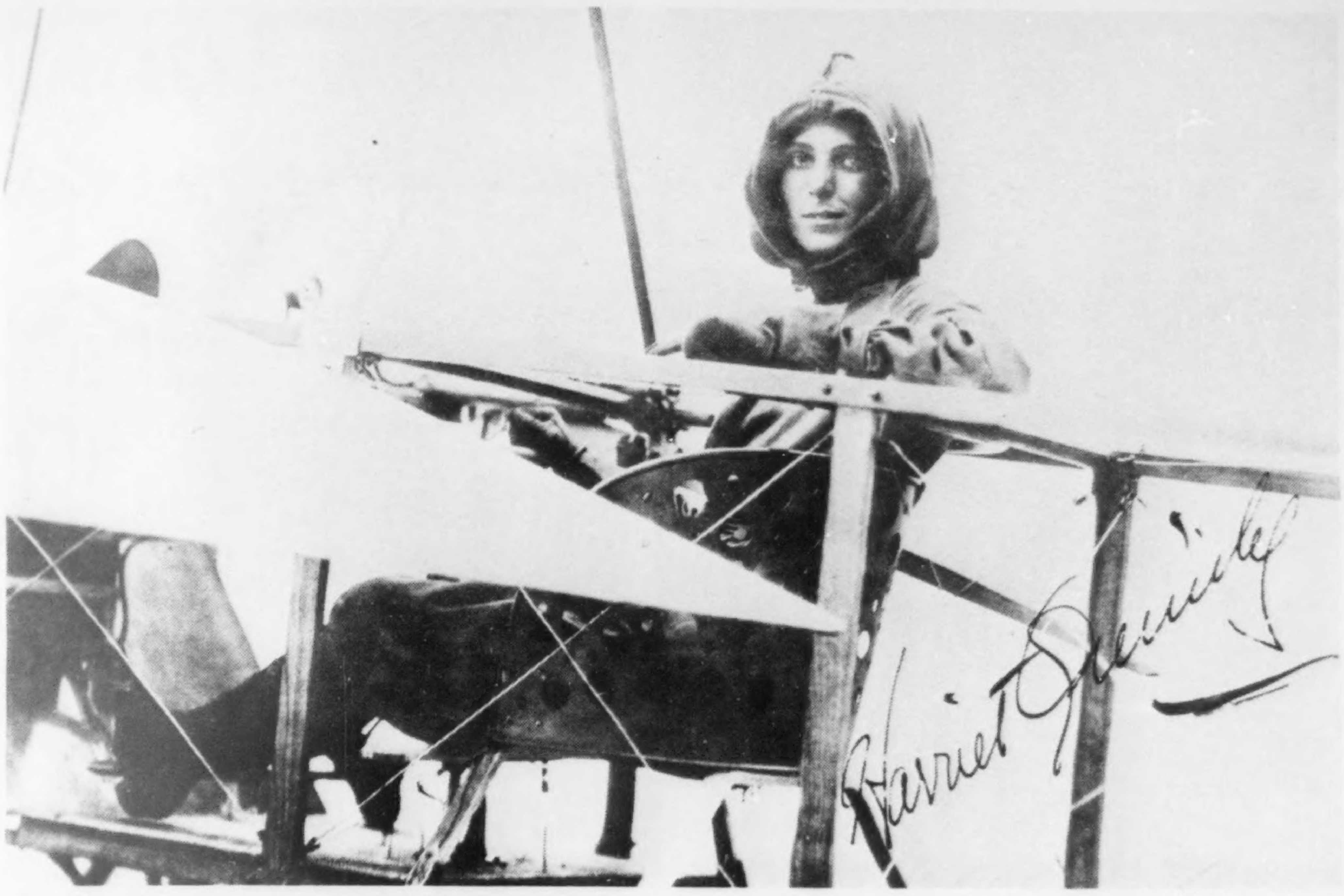
After more practice, Ms. Scott joined the Curtiss Exhibition Team. Billed as "The Tomboy of the Air," she performed such daring feats as flying inverted, and zooming under bridges. In her famous "Death Dive," she would plummet straight down from 1200 meters (4000 feet), sometimes not leveling out until she was only 60 meters (200 feet) from the ground.

Blanche Scott flew without a license, as the U.S. government did not require pilots to have licenses until 1926. The first woman in the United States (and the second in the world) to earn her pilot's license—although she was not obligated to do so—was Harriet Quimby. The Moisant School of Aviation at Hempstead, N.Y., was more willing than other schools to take women as students, and Ms. Quimby took lessons there in a Blériot-type 30-horsepower monoplane. On Aug. 1, 1911, she passed the test for her license and received Féderation Aéronautique Internationale certificate Number 37. Almost immediately, she was asked to join the Moisant International Aviators, an exhibition team, and traveled with them to Mexico City where they performed at the inauguration of President Francisco Madero.

In March 1912, Ms. Quimby sailed for Europe to begin preparations for what would be her most famous exploit—the first flight across the English Channel by a woman pilot. In France, she acquired a new Blériot 50-horsepower monoplane and had it shipped to Dover, England.

At 5:30 a.m. on April 16, 1912, she





Harriet Quimby (above) was the first U.S. woman to receive a pilot's license. She became the leading female pilot of the early 1900s and was the first woman to fly solo across the English Channel.

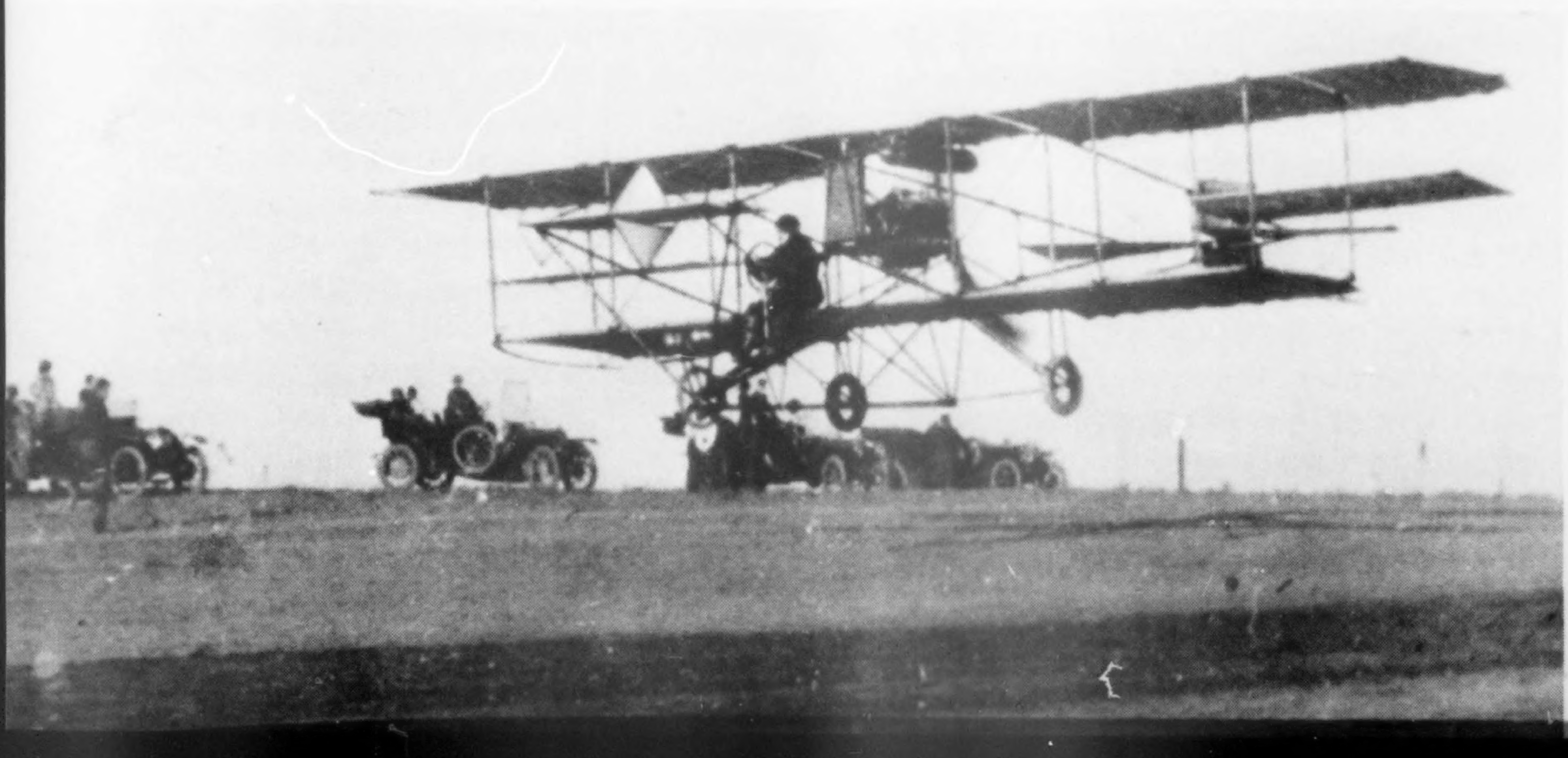
took off from the heights of Dover. Plagued with very poor visibility for most of the flight, she nevertheless landed successfully on the beach at Hardelot, 40 kilometers (25 miles) south of Calais, France. Ms. Quimby was feted in Paris and London and returned in triumph to the United States in May. She was a bright new symbol of what American women could accomplish.

In late June, she was invited to participate with other leading fliers of the time in the Harvard-Boston Aviation Meet. On July 1, while Ms. Quimby was taking the manager of the Meet on a short flight over Boston Harbor, the airplane suddenly dove sharply and flipped over. Both pilot and passenger were thrown out and killed.

Many other women were flying actively in the early part of the century. By the outbreak of World War I, 11 women had received their pilots' licenses, and countless others were flying without one, never having bothered to take the test in those preregulation days. As might be expected, many of these women strongly urged the U.S. government to allow them to fly as part of the war effort, but were denied the chance. They did domestic flying, however, for armed forces recruiting and Red Cross and Liberty Loan drives.

The women mentioned here—and others, such as Matilde Moisant, Ruth Law, Katherine and Marjorie Stinson—are a vital part of the history of U.S. aviation. Many of these early women pilots lived well into the space age. They must have taken much pride as they watched the progress U.S. women made in aviation, progress that would not have been possible had their predecessors not dared to defy convention, try their wings, and fly.

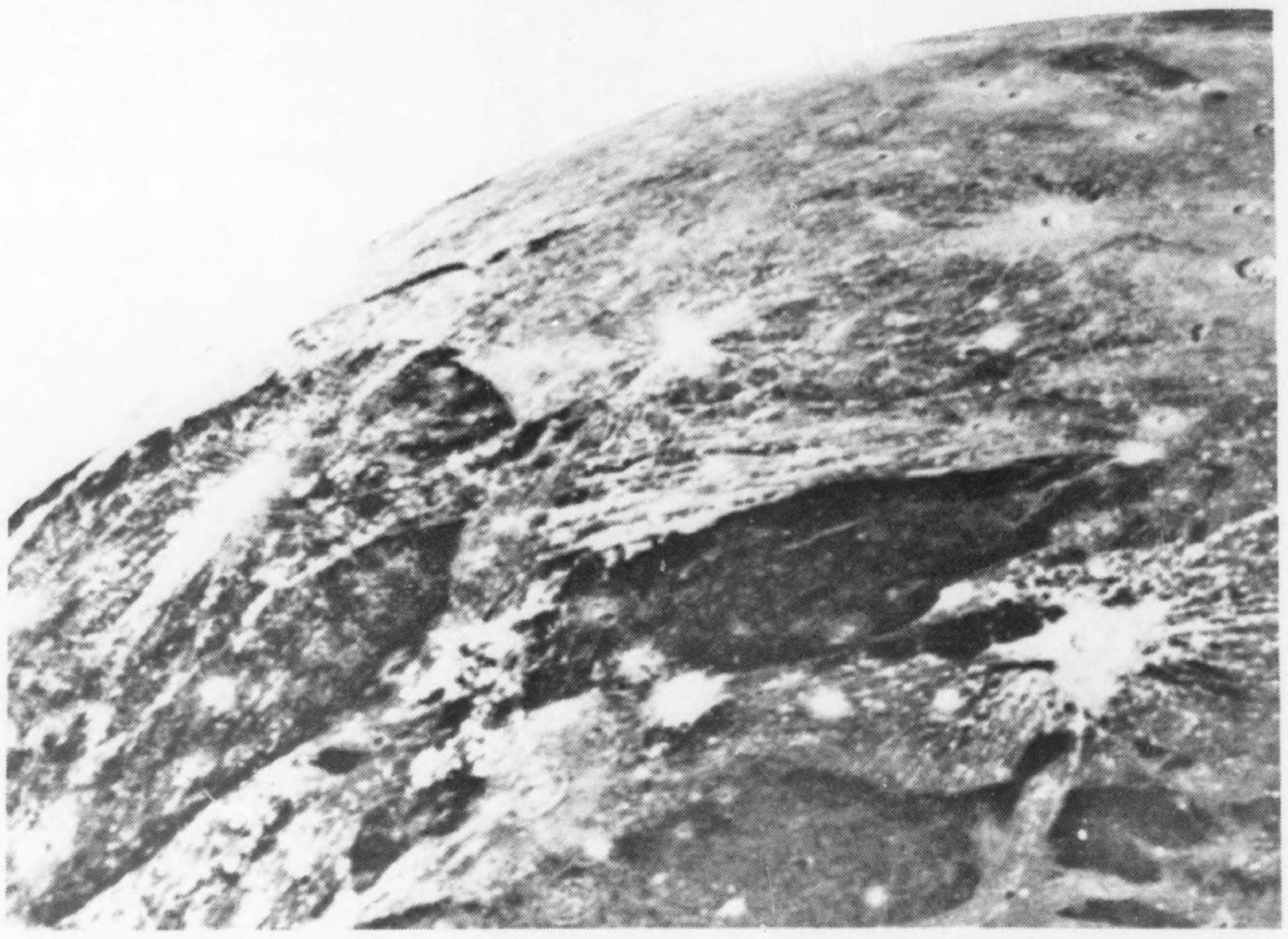
Above: Matilde Moisant was a member of a well-known family of pilots. Her heavy tweed flying suit once saved her life when her plane burst into flames upon landing. The insignia on her suit is a traditional good luck symbol. Below: On Sept. 2, 1910, Blanche Stuart Scott became the first U.S. woman to solo in a heavier-than-air craft. Right: Hélène Dutrieu, awarded the French Legion of Honor in 1913, flew in several early U.S. air meets. In 1912, she beat 14 men in an air race in Florence, Italy.



Lunar and Planetary Toponymy

the process of naming features on the Moon and planets has had a tumultuous history

by Farouk El-Baz
Research Director
Center for Earth and Planetary Studies, NASM



Earth's Moon was the first fertile ground for celestial chartmakers; above is an Apollo II view of a full lunar disk with dark circular maria surrounded by bright and heavily cratered highlands. Today, toponymists tackle the job of naming many new lunar and planetary features discovered by recent interplanetary probes. Right, dark and bright markings, grooves, and craters on Ganymede (one of the moons of Jupiter) revealed by Voyager 1.

Galileo Galilei started it all 370 years ago. As this great Italian scientist first trained a crude telescope at the Moon, he observed rough, bright regions and smooth, dark plains. The lighter areas he called *terrae,* Latin for lands (now called uplands or highlands). The darker parts he referred to as *maria,* the Latin word for seas.

Galileo was the first to publish a lunar feature map, and the first to recognize that the Moon's face was pockmarked by craters and other depressions. Thus began the often tumultuous history of lunar toponymy (region and place names).

Scores of astronomers followed Galileo's footsteps in observing and charting the Moon. By the end of the 17th Century, more than 25 maps of the Moon had been produced.

The most lasting nomenclature was devised by Giovanni Riccioli, an Italian Jesuit who, in 1651, published a lunar map based on observations by his pupil, Francesco Grimaldi. This map was the foundation of current lunar nomenclature. Riccioli gave the dark, smooth plains romantic names such as *Mare Tranquillitatis* (Sea of Tranquillity), *Oceanus Procellarum* (Ocean of Storms), and *Sinus Iridum* (Bay of Rainbows). He named craters after famous personalities, chiefly astronomers, philosophers, and scientists.

Riccioli's scheme was also logical. The names were arranged in chronological order from north to south on the face of the Moon. In addition, he grouped nationalities, interests, and schools of thought in the same areas.

Riccioli's nomenclature reflected the scientific opinions of the day. Like other scientists of that period, he did not admit that the Earth is in orbit around the Sun (although some think he secretly believed in the Sun-centered Universe). Thus the name of Copernicus, in Riccioli's own words, was "flung into *Oceanus Procellarum.*" In this Ocean of Storms we also find the name of Kepler and, on a tiny, undistinguished crater, Galileo, whose ideas were still at odds with those of the Church. On the other hand, the name of Ptolemaeus (Ptolemy), whose idea of an Earth-centered Universe was blessed by the Church, graced a prominent crater.

Riccioli's system was used by most later selenographers (mapmakers of the Moon's surface). But during the latter half of the 19th Century, astronomers and selenographers in various countries drew new maps, adding new names and replacing the older nomenclature. Confusion spread.

The history of the mapping of Mars was similarly colorful, but somewhat shorter because of the limitations on what could be seen of Mars from Earth. Even Galileo could see almost no detail. But as astronomers obtained bigger and better telescopes, the martian surface began to unveil its secrets.

In 1659, Christian Huygens made the first informative sketch of Mars, showing a prominent dark marking and the south polar cap. Primarily through the work of William Herschel, a brilliant English scientist, a surprisingly Earth-like picture of Mars emerged as the 18th Century ended. Mars was observed to have a day-night cycle of approximately 24 hours; seasons associated with annual growth and shrinkage of the polar caps; and occasional obscuration of its features, attributed to clouds.

This view of Mars led to Earth-like

Far left, the lunar crater Copernicus with terraced walls and prominent central mountain peaks. Near left, detailed view of the meandering Rima Hadley, a long, narrow valley or channel on the Moon. Above, heavily cratered and furrowed terrain on Mercury.

nomenclature, with bright regions named continents and dark regions called oceans. In 1877, Giovanni Schiaparelli provided new terminology; skirting the obvious pitfalls of naming features after people, he concocted a romantic blend of biblical and mythological nomenclature. His geography of Mars placed *Libya* across the *Tyrrhenum Mare* (Tuscan Sea) from *Ausonia* (Italy). Schiaparelli located *Atlantis* between the seas of *Cimmerium* and *Sirenum* (from Homer's seas of the Cimmerians and Sirens). The bright land of *Elysium* he bounded by the darker areas of *Chaos, Styx,* and *Cerberus*. Schiaparelli's map was the first to show a profusion of "canals" on Mars.

Venus, the planet nearest Earth, escaped the scrutiny of early mappers because it concealed all of its features beneath thick clouds.

In 1921, the newly-formed International Astronomical Union (IAU) appointed a committee to standardize lunar nomenclature. Mary Blagg and Karl Müller published the IAU map and catalogue in 1935. The IAU continued to act as the authority for such nomenclature until the space age.

On Oct. 4, 1959, the Soviet Union launched Luna 3, which soon transmitted back to Earth the first photographs of the far side of the Moon, something never before seen by man. Soon afterwards, U.S. spacecraft circled, photographed, landed upon, and sampled the Moon. Suddenly, naming features on the Moon was no longer the privilege of astronomers, who took their time charting new features. Many maps of various scales had to be made to chart orbits, mark navigational points, select landing sites, and prepare astronauts to explore on foot. Engineers, geologists, cartographers, mission planners, and astronauts took part in naming the Moon.

Departures from the little-known IAU rules of naming lunar craters after deceased scientists became common. For a short period, the IAU approved the honoring of great historians, architects, composers, dancers, painters, and others who contributed to human culture.

Adding to the problems, spacecraft started revealing features on Mercury, Venus, Mars, and the martian moons. In the excitement of discovery, the planetary nomenclature process began haphazardly. Copernicus, Schiaparelli, and others had their names on both the Moon and Mars. The American astronomer Gerard Kuiper was commemorated on the Moon, Mars, and Mercury. Something had to be done, and quickly.

The IAU took the lead. It created the Working Group of Planetary System Nomenclature (WGPSN), which developed a workable solution.

Features on the outer Solar System planets (Jupiter, Saturn, Uranus, Neptune, and Pluto) and their moons would receive names from ancient mythology. On Venus, female names would be used in addition to those of radio and radar scientists and engineers, because the features of Venus were revealed only to radar sensors. Mars would keep the few names of scientists; its small craters would be named from an international list of villages on Earth. Mercury would be reserved for non-scientists. The Moon would remain a place for commemorating great scientists. The IAU also compiled a list of the types of planetary surface features that receive names. The IAU list of lunar and planetary feature terms starts on the back cover of this issue of *Air & Space*.

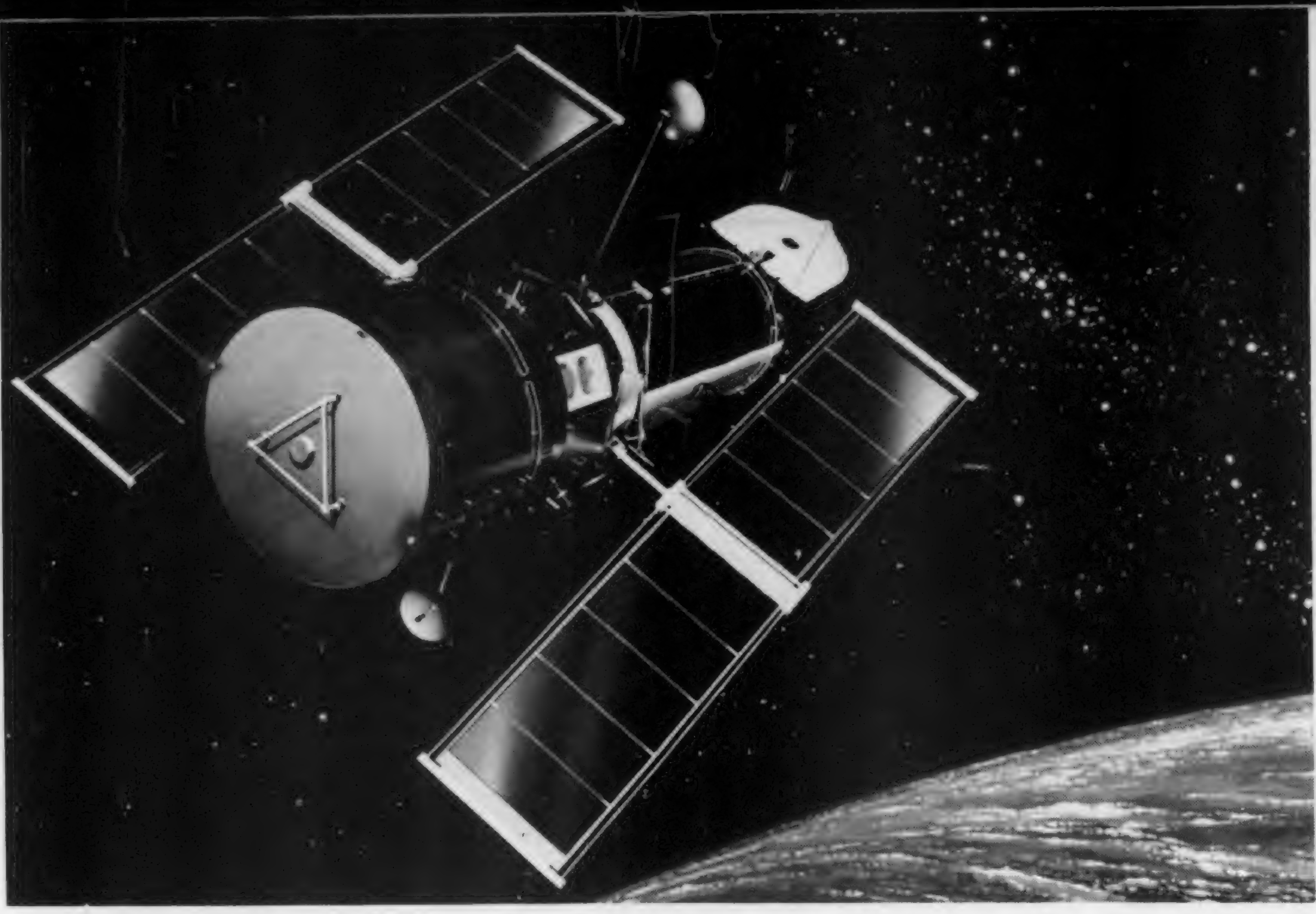
In William Shakespeare's play, *Romeo and Juliet,* Juliet asks, "What's in a name?"

In lunar and planetary toponymy, at least, there is a great deal.

Acknowledgement: Parts of this essay are based on an article by the author that appeared in the January 1979 issue of Smithsonian.

New Eyes [illegible]he Universe

NASM's new Spacearium show explores the wonders of the new astronomy



The Space Telescope shown in this artist's concept—and in the new NASM Spacearium show—is scheduled to be placed in Earth orbit by the Space Shuttle during the early 1980s. Designed for an orbital lifetime of at least 10 years, the Space Telescope will photograph deep space objects, obtaining images and spectra of much higher quality than can be attained from ground-based observatories. It will detect objects 50 times fainter than the faintest objects observed with existing terrestrial telescopes.

by Von Del Chamberlain
Astronomer
Department of Space Science and Exploration, NASM

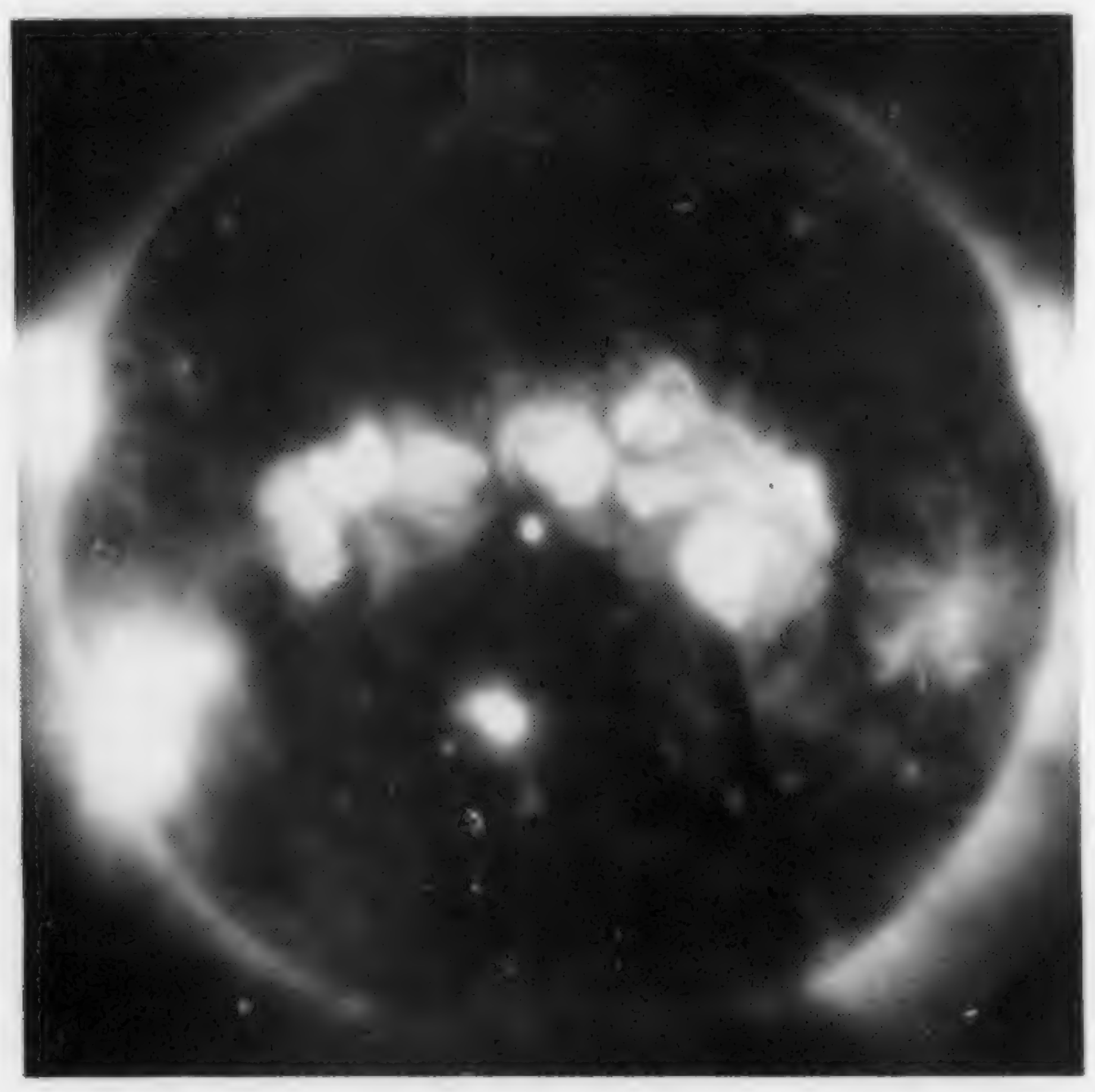
Pulsars, neutron stars, black holes, and quasars are all relatively new terms for exotic objects in space—objects not even widely contemplated until recently. They are part of the vocabulary of the new astronomy, the space-age astronomy that uses new theories, tools, and observations.

How have we become aware of stars that rotate many times each second (pulsars), stars so dense that light cannot even escape them (black holes), or star-like objects that radiate as much energy as whole galaxies (quasars)? The answers involve astronomy's new eyes, both on Earth and in space.

Some objects in space emit light; if they are not too faint or distant, we can see them. But most astronomical things emit much energy to which our eyes are not sensitive, and some objects emit only energy that we cannot see. To study the invisible universe, scientists have invented devices to measure radio, infrared, and ultraviolet emissions, as well as x-rays and gamma rays. Two of the radiant energy spectral regions—visible light and radio—penetrate the Earth's atmosphere. The others are absorbed by atmospheric gases; to study them, we must send our instruments beyond the atmosphere.

A new program at the National Air and Space Museum's Albert Einstein Spacearium soon will introduce the new astronomy and describe the tools and methods that make it possible. "New Eyes on the Universe" will take NASM visitors high atop Arizona's Mt. Hopkins to see the world's most advanced earthbound telescope, the Multiple Mirror Telescope (see "MMT," November-December 1979 *Air & Space*, pages 12-13). Then the armchair tour will move on to the National Radio Astronomy Observatory, Green Bank, W.Va. Visitors will "see" through the eyes of a most unusual satellite called the Einstein Observatory, a device that focuses x-rays to form images. Viewers also will watch the deployment of the large Space Telescope from the Space Shuttle Orbiter, an event expected to happen in the early part of this decade. Visitors will witness an exploding supernova, get a peek at a pulsar, see the effects of a black hole, and more.

The 30-minute program will run daily, starting about mid-May, with several showings throughout the day. "New Eyes on the Universe" will provide an excellent opportunity for school groups, as well as individuals, to learn about our newest perspectives on both the nearby and the remote components of the cosmos.



X-ray images of the Sun (above) and the Crab Nebula (optical image shown at left) are among the wonders of nonvisible astronomy that will be featured in NASM's new Spacearium show.

The Spacearium Shop

of the National Air and Space Museum offers for sale a wide variety of high-quality, reasonably priced books, posters, and other items related to the exploration of the air and space. An abbreviated list of books for sale appears below.

To order books, mark the number of copies of each book you wish to purchase. Cut out or copy this advertisement and mail with your check or money order to

Program Coordinator, Dept. AS-380
Room P-701
National Air and Space Museum
Smithsonian Institution
Washington, DC 20560
(202) 381-4084

Please do *not* send cash. Foreign orders should include $1.00 *per mail-order item* to cover air mail shipping.

Number of copies

___ @ $ 3.25 **Aircraft of the National Air and Space Museum.** The catalogue of the National Aeronautical Collection. Paper

___ @ $ 2.75 **Rockets, Missiles, and Spacecraft of the National Air and Space Museum.** The catalogue of the National Astronautical Collection. Paper

___ @ $ 5.20 **Charles A. Lindbergh: An American Life,** by Tom D. Crouch. Paper

___ @ $ 3.25 **The Artist in Space,** by James Dean. The story of the commission of art during the U.S. space program. Paper

The Wright Brothers: Heirs of Prometheus, Richard P. Hallion, ed.
___ @ $16.25 Hardbound
___ @ $ 7.20 Paper

Apollo: Ten Years Since Tranquillity Base, Richard P. Hallion and Tom D. Crouch, eds.
___ @ $18.75 Hardbound
___ @ $ 8.20 Paper

___ @ $ 3.75 **U.S. Women in Aviation Through World War I,** by Claudia M. Oakes. Paper

___ @ $ 6.20 **Excalibur III: The Story of the P-51 Mustang,** by Robert C. Mikesh. Paper

___ @ $ 7.20 **The P-80 Shooting Star: Evolution of a Jet Fighter,** by E. T. Wooldridge, Jr. Paper

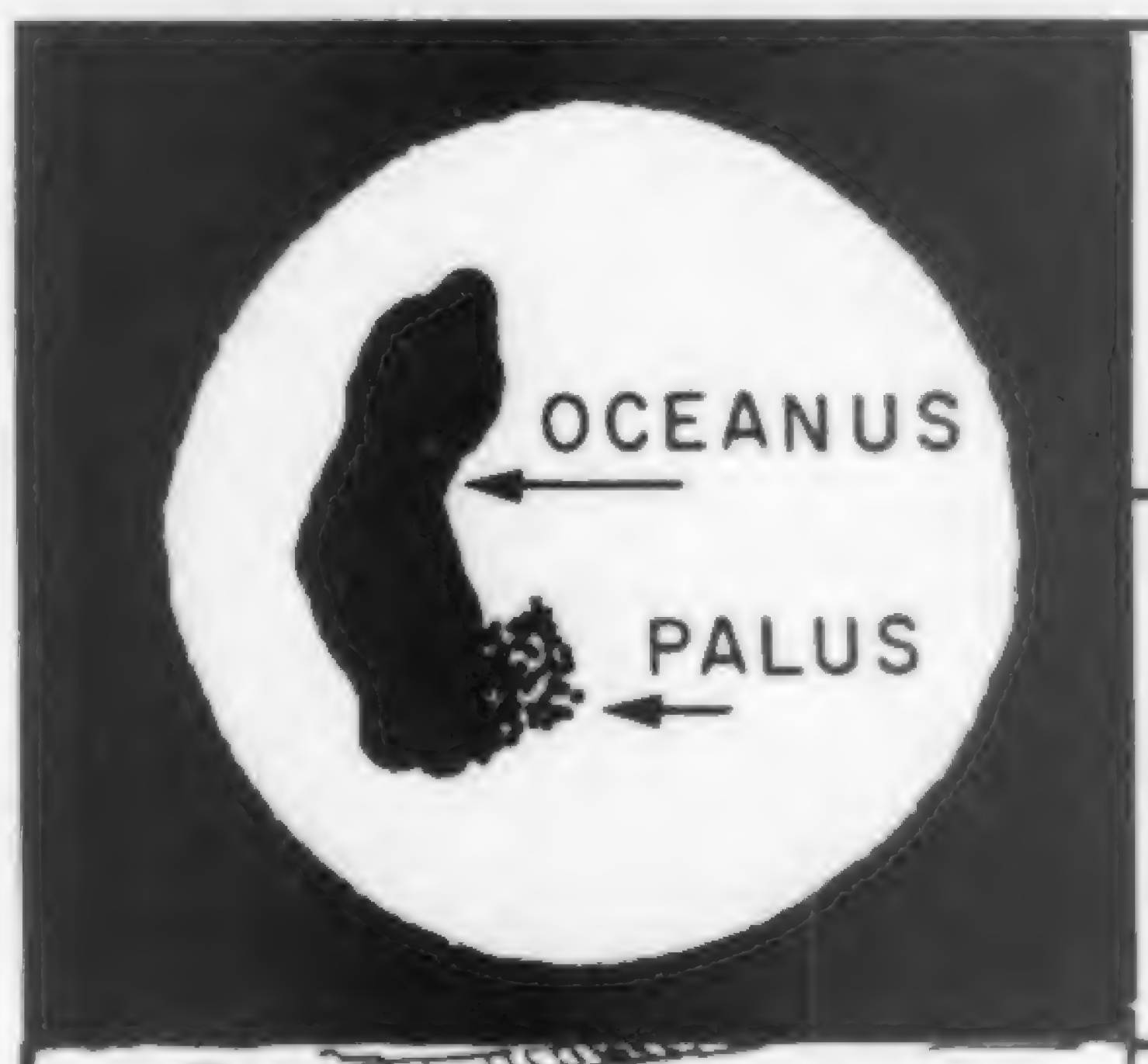
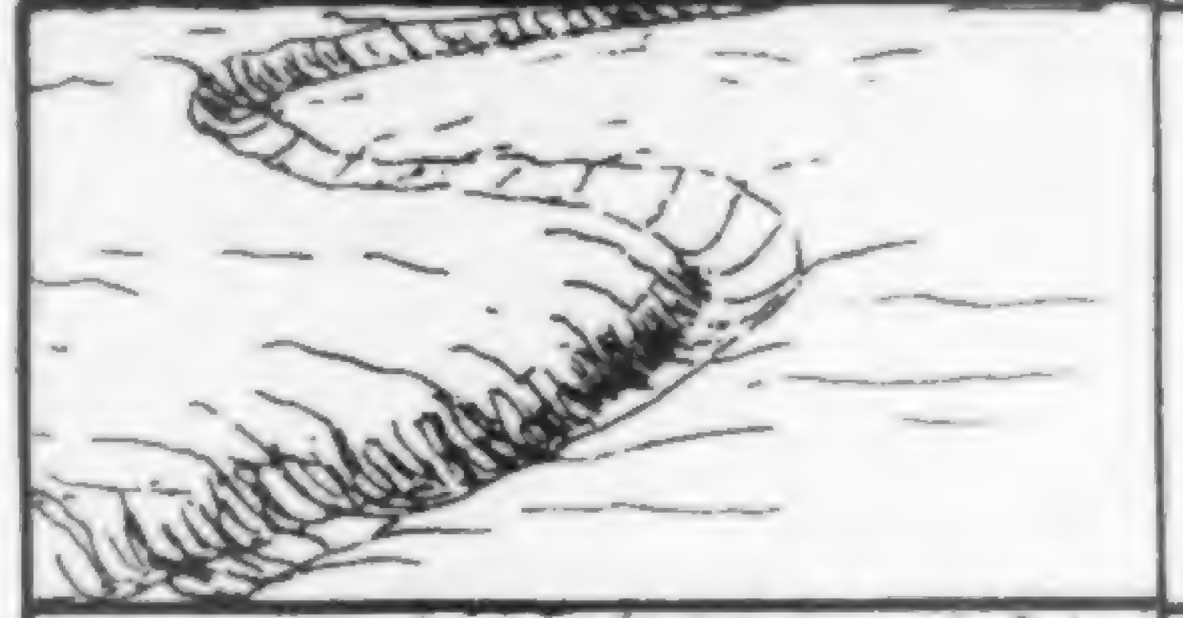
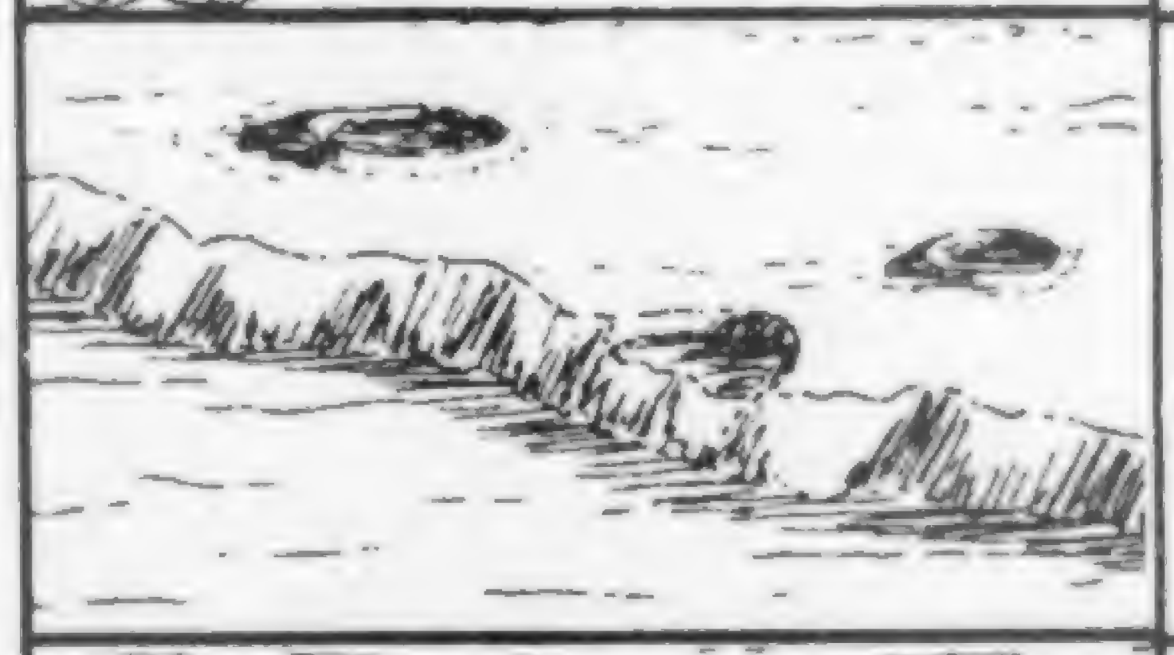
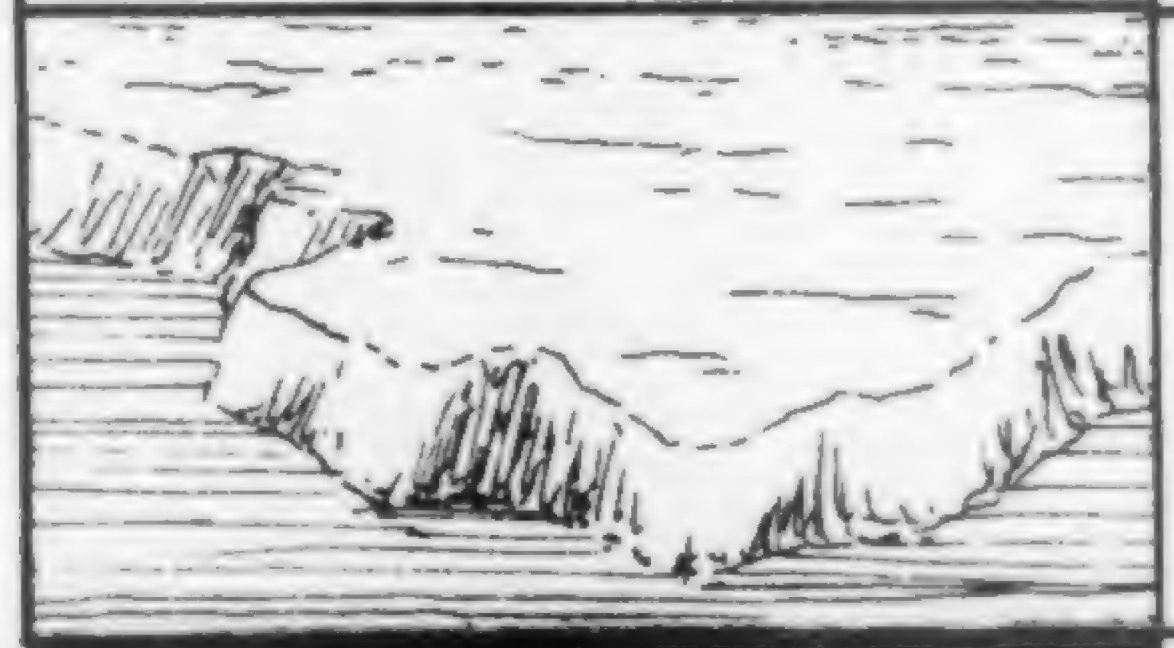
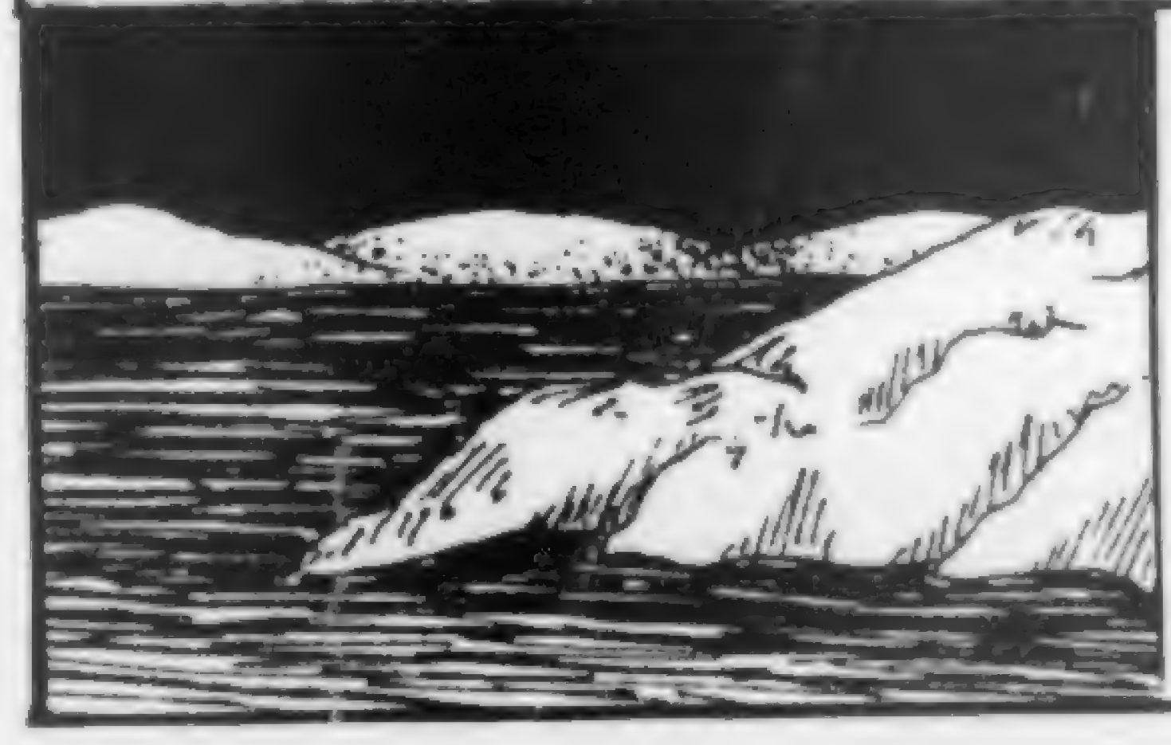
Jet Age: Forty Years of Jet Aviation, Walter J. Boyne and Donald S. Lopez, eds.
___ @ $18.75 Hardbound
___ @ $ 9.20 Paper

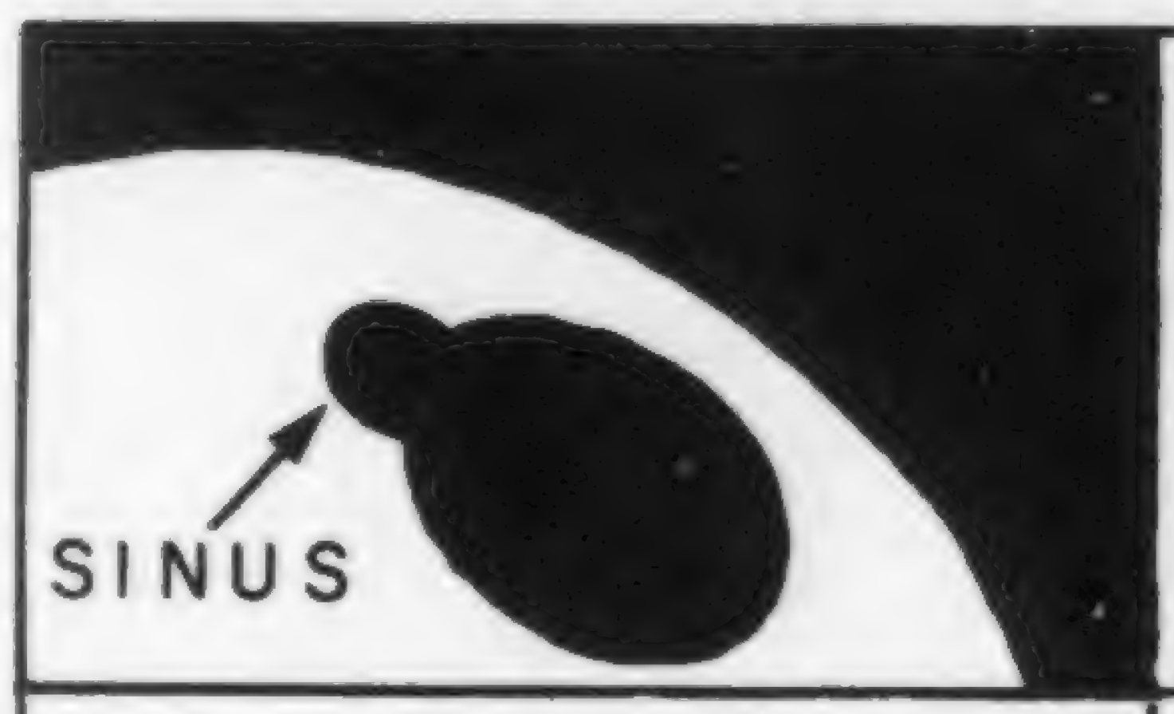
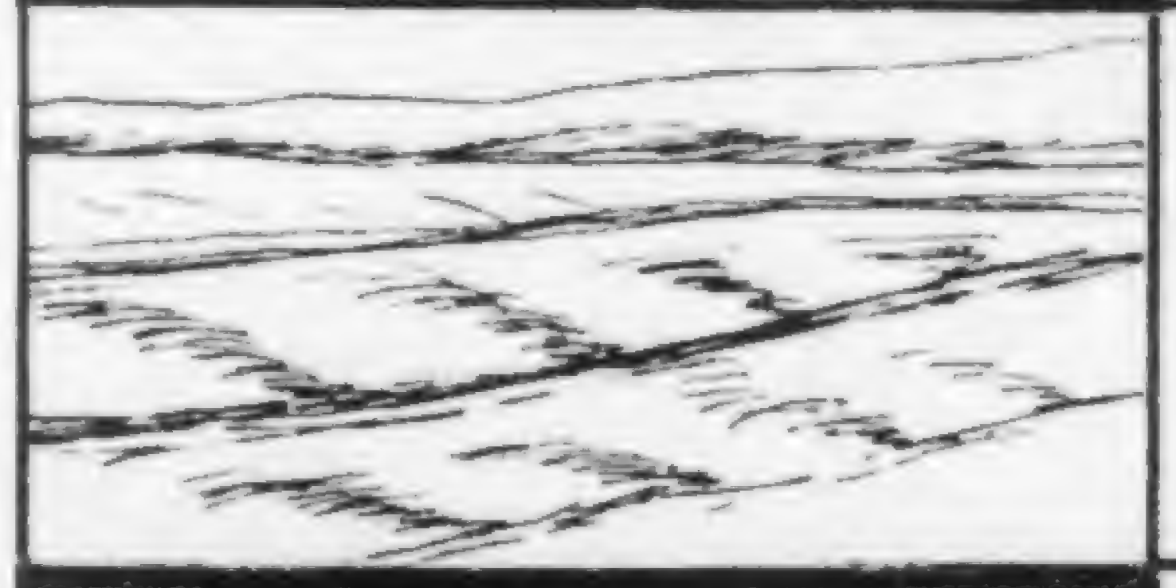
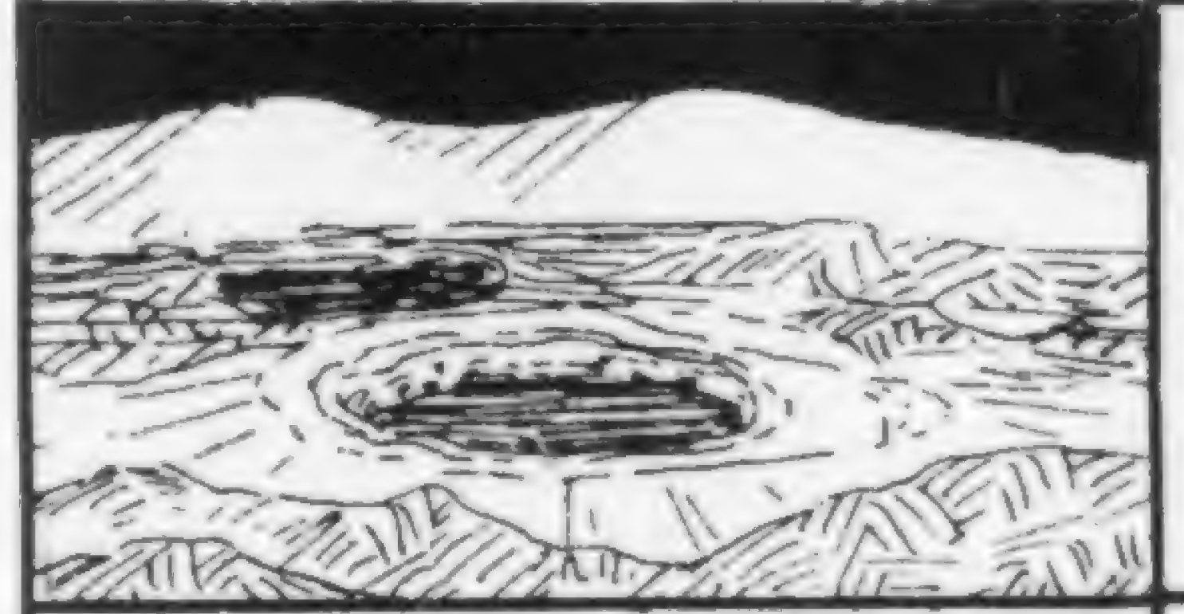
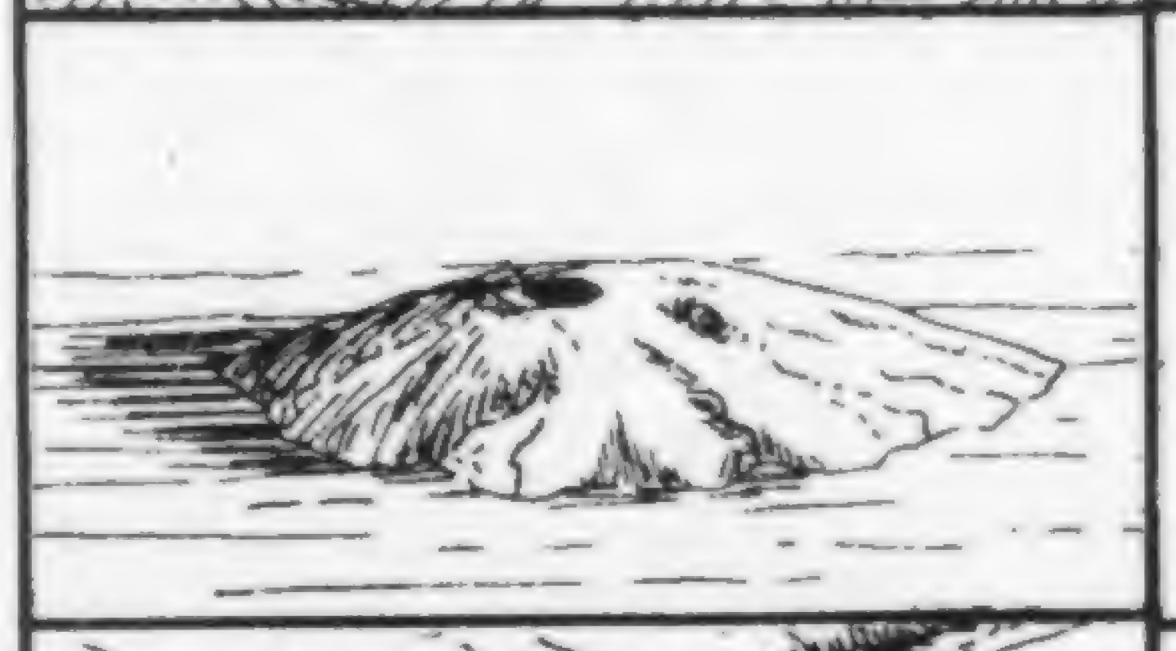
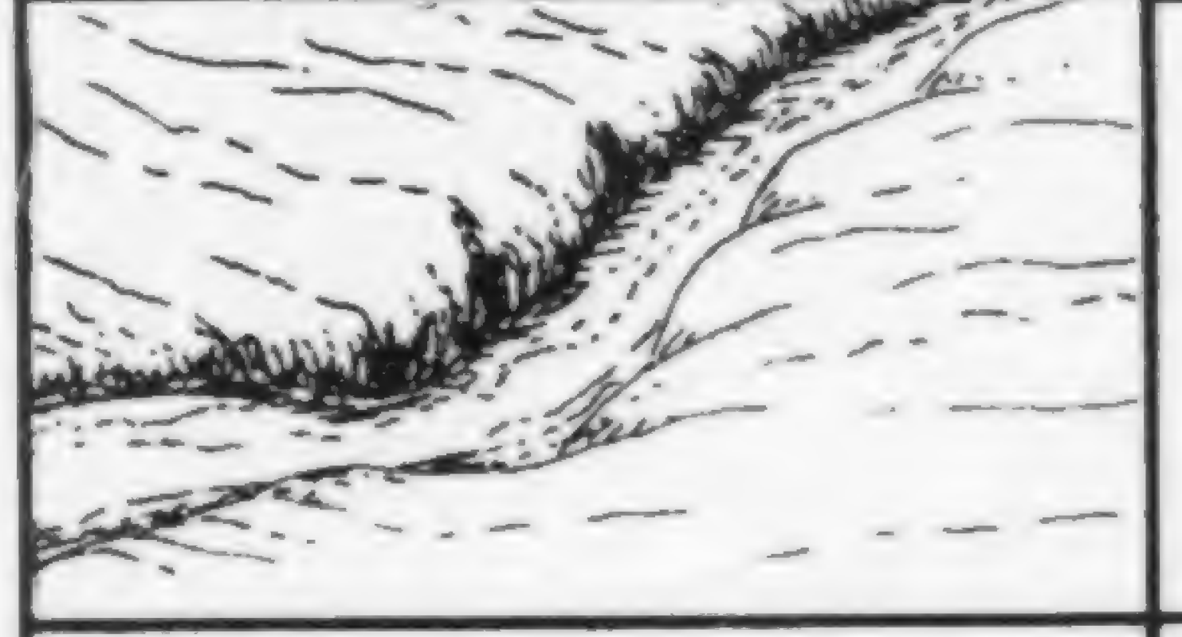
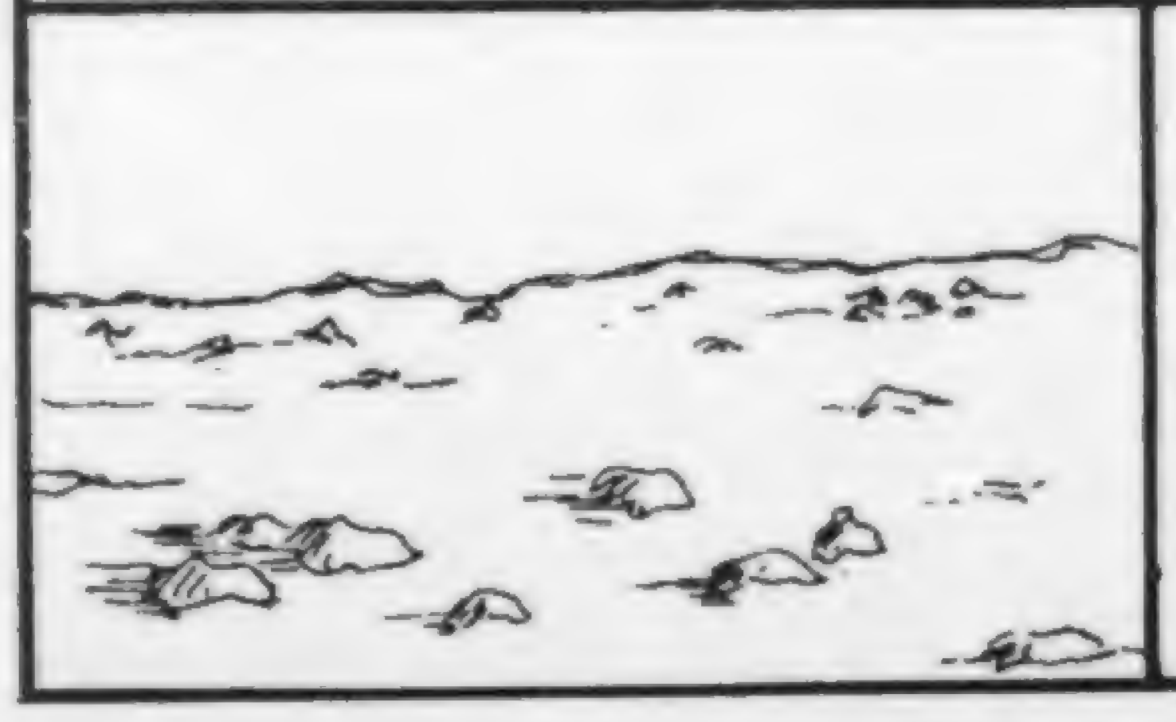
☐ Please send me FREE information about the Spacearium Shop's Aviation Relic Series; World War posters; Images from Air and Space posters; Milestones of Flight commemorative (philatelic) covers; and other Spacearium Shop items for sale.

NAME ______________________
ADDRESS ______________________
CITY ______________________
STATE ______________ ZIP ________

Planetary feature terms

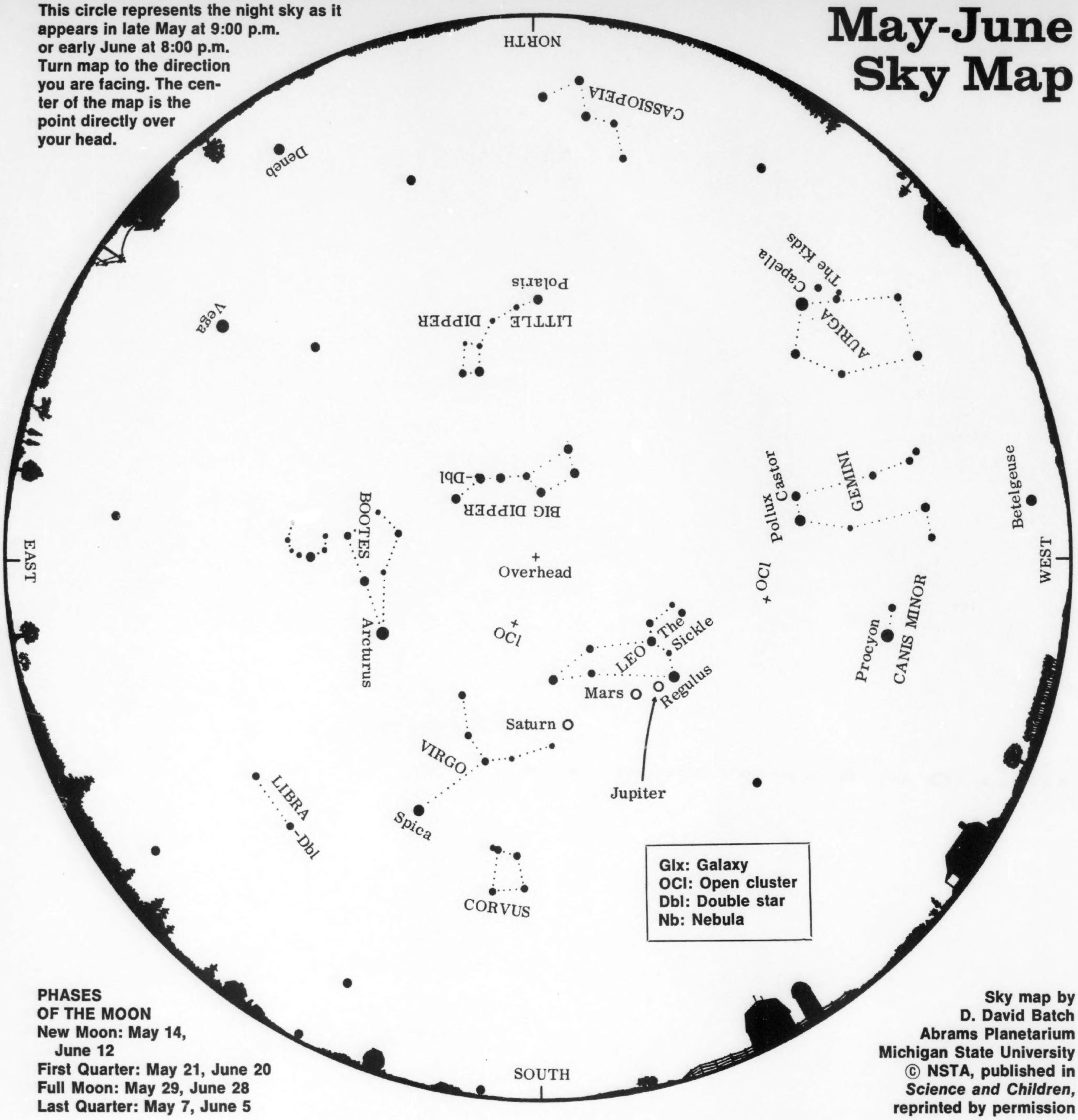
continued from back cover

	**Oceanus** "Ocean"; vast, irregular, dark, smooth region (Oceanus Procellarum only)
	Palus (Paludes) "Swamp"; small, irregular area, on the Moon a mixture of mare and highland material
	**Rima (Rimae)** Channel; long narrow valley, fissure, or channel on the Moon
	**Rupes (Rupes)** Linear scarp or cliff face
	**Scopulus (Scopuli)** Cliff; lobate or highly irregular scarp
	**Promontorium (Promontoria)** Promontory; extension of lunar mountains into Mare

	**Sinus (Sinus)** "Bay"; semi-enclosed dark area opening into a Mare on the Moon
	**Sulcus (Sulci)** Complex area of sub-parallel furrows and ridges
	**Terra (Terrae)** Uplands or highlands
	**Tholus (Tholi)** Dome; isolated domical mountain or hill
	**Vallis (Valles)** Valley; canyon-like, often sinuous trough
	**Vastitas (Vastitates)** "Wasteland"; extensive plains of lowlands, only on Mars

May-June Sky Map

This circle represents the night sky as it appears in late May at 9:00 p.m. or early June at 8:00 p.m. Turn map to the direction you are facing. The center of the map is the point directly over your head.


NORTH
CASSIOPEIA
Deneb
The Kids
Capella
AURIGA
Polaris
LITTLE DIPPER
Vega
-Dbl
BIG DIPPER
BOOTES
Castor
Pollux
GEMINI
Betelgeuse
EAST
WEST
Overhead
OCl
OCl
Arcturus
LEO
The Sickle
Regulus
Mars
Saturn
Jupiter
VIRGO
Spica
LIBRA
-Dbl
Procyon
CANIS MINOR
CORVUS
Glx: Galaxy
OCl: Open cluster
Dbl: Double star
Nb: Nebula
SOUTH

PHASES OF THE MOON
New Moon: May 14, June 12
First Quarter: May 21, June 20
Full Moon: May 29, June 28
Last Quarter: May 7, June 5

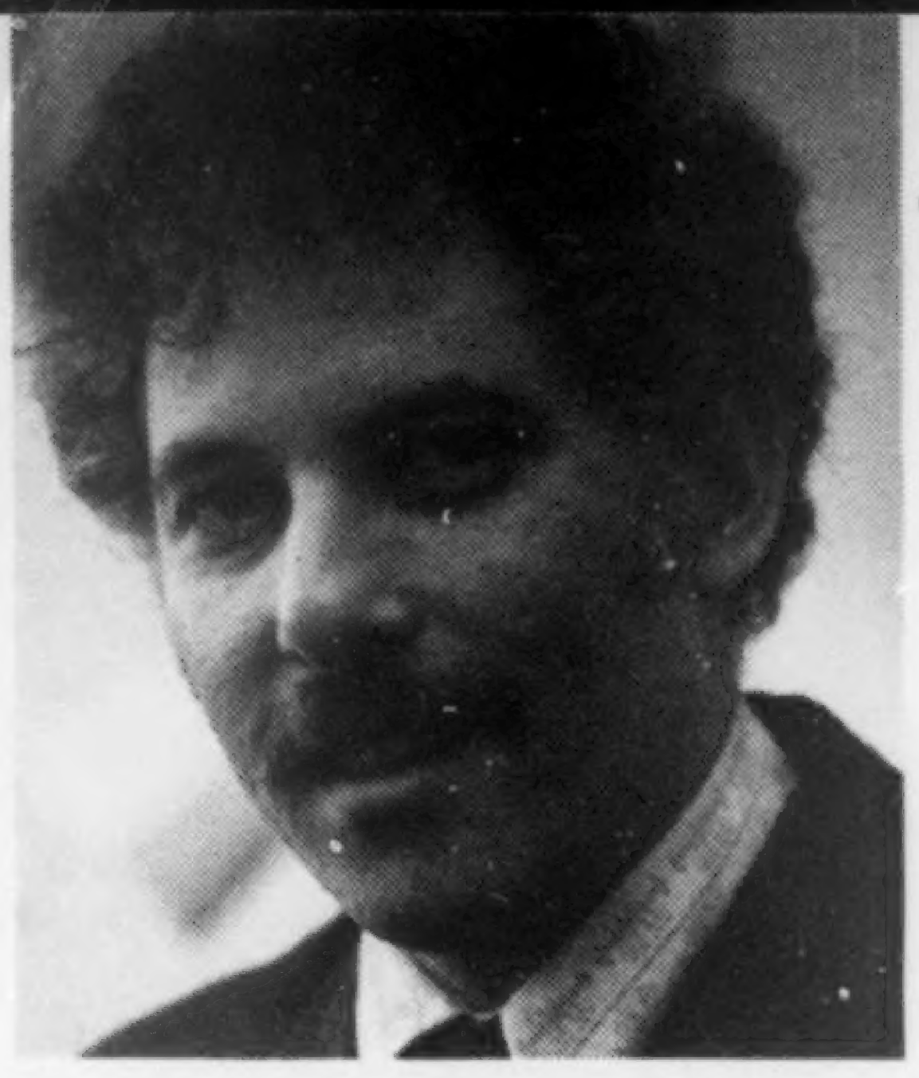
Sky map by
D. David Batch
Abrams Planetarium
Michigan State University
© NSTA, published in *Science and Children*, reprinted by permission

by T. H. Callen II
Production Specialist
Albert Einstein Spacearium, NASM

What better way to end the school year than to have the five naked-eye planets appear in review? After passing behind the Sun on May 13 (superior conjunction), Mercury can be seen in the evening sky. At the end of May, it will be visible about 15° above the western horizon shortly after sunset; on June 1, it will be visible soon after sunset low in the west, close to Venus. Throughout May, Venus will be easily visible in the west, setting about three hours after the Sun in early May. On May 8, Venus will attain a magnitude of —4.2, 95 percent of its greatest possible brilliance, —4.4. It will still be visible in early June, but by mid-June it will be too close to the Sun for observing, passing between Earth and Sun (inferior conjunction) on June 15.

In May, Mars (in Leo) will be high in the south at dusk, setting about six hours after sunset. On May 4, it will complete a third and final approach (conjunction) to Jupiter (part of a series that began last December), passing less than one degree above Jupiter as seen from Earth. In June, Mars will be high in the southwest sky, dropping below the horizon about four hours after sunset. Jupiter, also in Leo, has approximately the same sunset directions and setting times as Mars.

During May, Saturn will be high in the south at sunset, setting at midnight. (Look for Saturn at the eastern border of Leo.) June will find Saturn in the southwest, setting 4½ hours after the Sun. The rings of Saturn are invisible, since they are essentially edge-on as seen from Earth. Through a telescope, Saturn now appears like a smaller, more oblate version of Jupiter. Saturn will be occulted (eclipsed) by the Moon on June 19; this event will be visible in North America, southwest Iberia, Africa, and from the North Atlantic.



OUTREACH

by Kerry M. Joëls

Chief, Education Services Division

"But it is all I can do just to teach the required curriculum!" Many teachers echo the sentiments of this Illinois high school chemistry teacher when asked to introduce something above and beyond the mandated curriculum into the classroom.

Values education, which has become extremely popular since the "humanization" movement began in the late 1960s, is likely to produce such a response from a teacher. Science educators who are particularly aware of the facts, concepts, and processes that they are required to teach often become befuddled by the need to teach the social values of the objective curriculum. Should values education (i.e., aspects of affective learning) be relegated only to social science courses? Should students study a discipline without the relativism of social, behavioral, or aesthetic considerations? Why teach values in a science classroom? Why examine how the student interacts with science?

It is a simple fact that only about half of the students we teach go to college. Even fewer graduate, and an even smaller fraction achieve any competency in science and technology. This weak link in the education chain becomes serious, because science and technology pervade our lives.

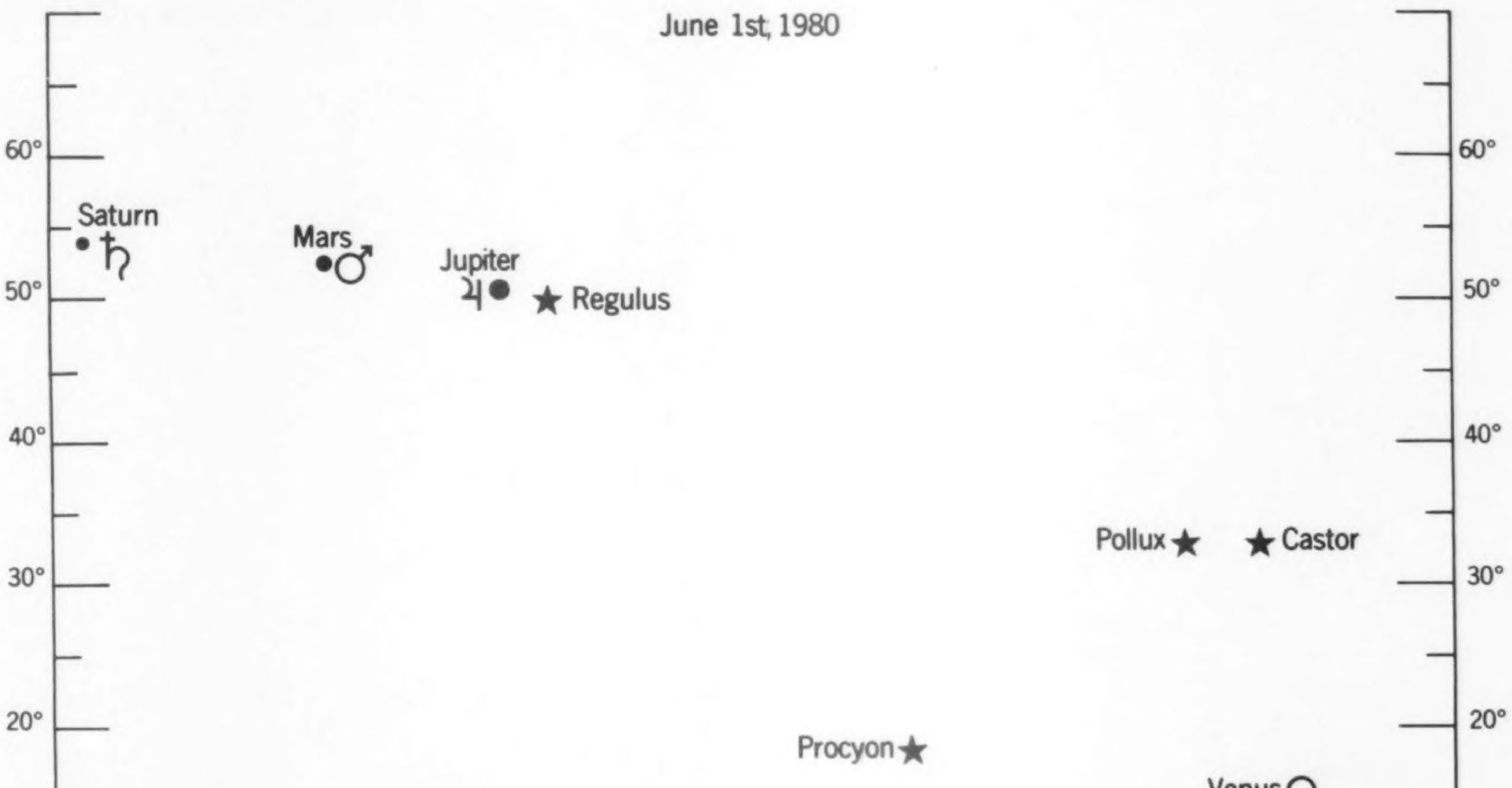
Given the gulf that often separates scientists and non-scientists, who is better able to teach these concepts than the science teacher? If we do not teach students how to value in the area of science, we may ultimately—through ignorance, overreaction, or hostility—cause massive dislocations in our society.

American society in particular is predicated on the intelligent participation of the individual. Too often, extremely complex military, technological, and scientific programs are created or eliminated according to the whims of those in power. The public usually is completely unprepared to speak to those needs based on a coherent understanding of the nature, process, and meaning of science.

Science lends itself very well to values clarification and values education. Important environmental, biological, and psychological considerations arise every day in our lives.

Fundamental questions relate directly to subject matter. The geology of earthquakes, flooding, and resource development; the biology of environmental and genetic modification; the physics of nuclear energy; and the chemistry of pollution, warfare, and medicine all provide spontaneous starting points for debates, role playing, research projects, and presentations. Community resources from government, industry, and consumer groups make valuable and stimulating changes from the lecture/lab routine of science instruction.

Do you do this at the expense of fundamental scientific principles? Perhaps so, because the students will forget most of those scientific principles and facts long before they get a chance to use them in college. However, they may remember the approach to learning, and may actually continue to study science because of their intense interest in its social value.



This diagram shows all five of the naked-eye planets approximately ½ hour after sunset on June 1, 1980. The planets' positions are marked by solid circles; the circles' sizes indicate the planets' relative brightness. Traditional astronomical symbols for the planets are printed next to the circles. Four bright stars—Regulus, in the constellation Leo; Procyon, in Canis Minor; and Castor and Pollux in Gemini—are shown as well. (See the May-June Sky Map, opposite page.) The azimuth axis along the bottom of the diagram marks compass points in degrees along the horizon, while the altitude axis along the side marks height above the horizon in degrees. The next similar evening grouping of these planets will not be seen until July 1984.

ILLUSTRATION CREDITS
Pages 1, 2, 4-5, 8-9: NASM Collection. Page 3: Smithsonian Kite Carnival, Tom Gregory; all others, NASM Collection. Page 6: top, NASA; all others, NASM Collection. Pages 7, 10-11: NASA. Page 12: Crab Nebula, Lick Observatory; all others, NASA. Pages 13, 16: Lunar and planetary toponymy art, Ann Gifford, NASM. Page 15: Planets chart, Jill Woodworth and T. H. Callen II, NASM.

Lunar and Martian Maps

Earth's Moon, a 107- by 71-centimeter (42- by 28-inch) map of the lunar surface with descriptive notes and diagrams, is available in paper (No. 02276) for $3.00 postpaid, or in lightweight plastic (No. 02376) for $4.00 postpaid from the National Geographic Society, Washington, D.C. 20036.

A 91- by 107-centimeter (36- by 42-inch) topographic map of Mars (No. I-961) is available for $1.50 postpaid from the U.S. Geological Survey, Branch of Distribution, 1200 South Eads St., Arlington, Va. 22202, or from USGS, Box 25286, Federal Center, Denver, Colo. 80225.

Be sure to include the correct order number(s) with your check or money order when ordering maps by mail.

THINK ALONG WITH PLANETARY SCIENTISTS

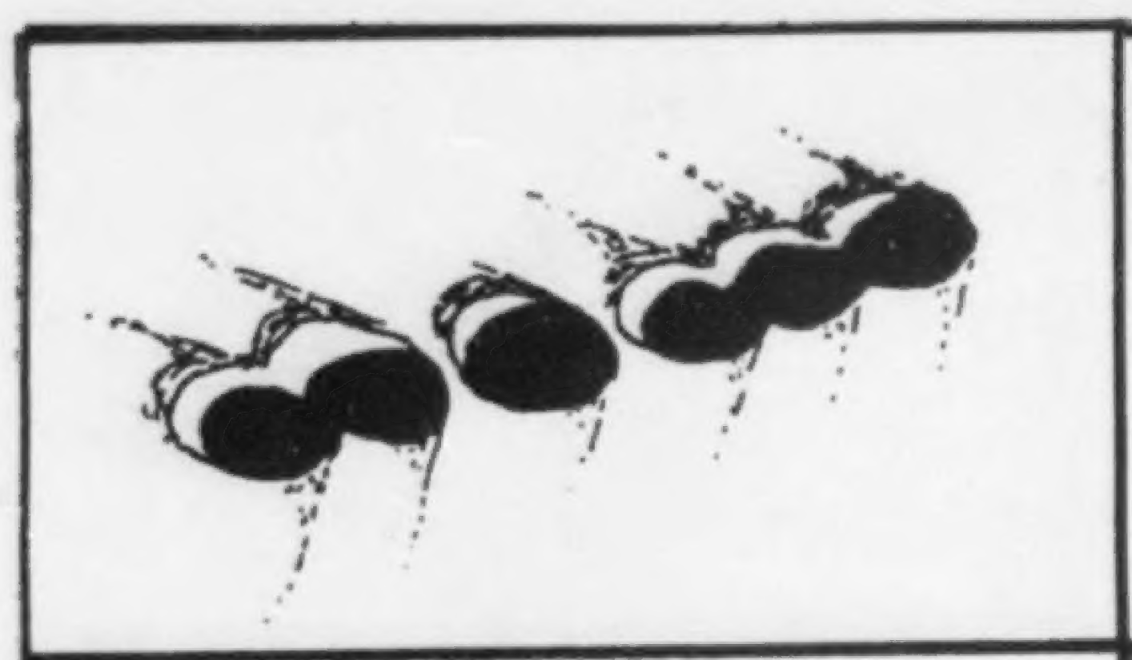
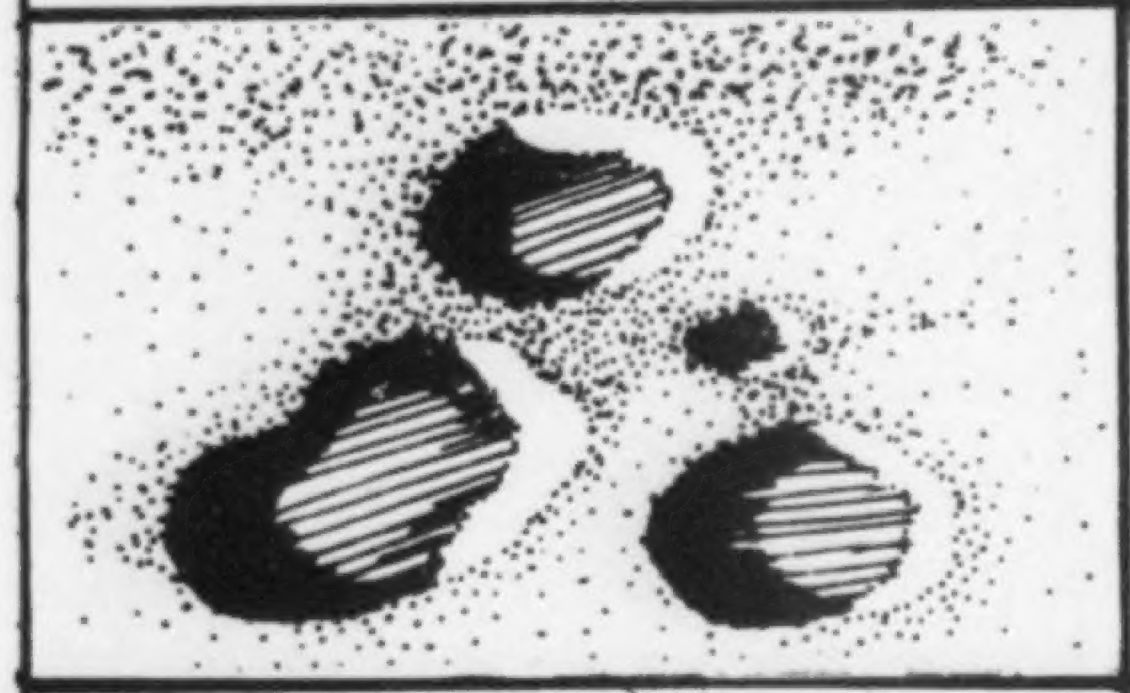
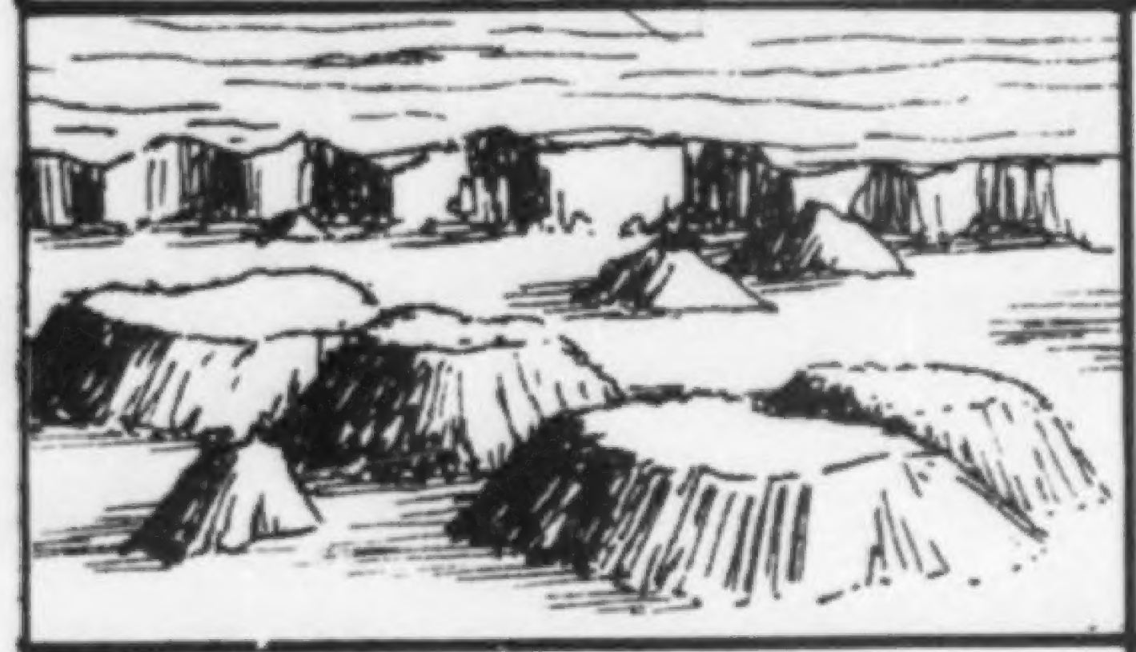
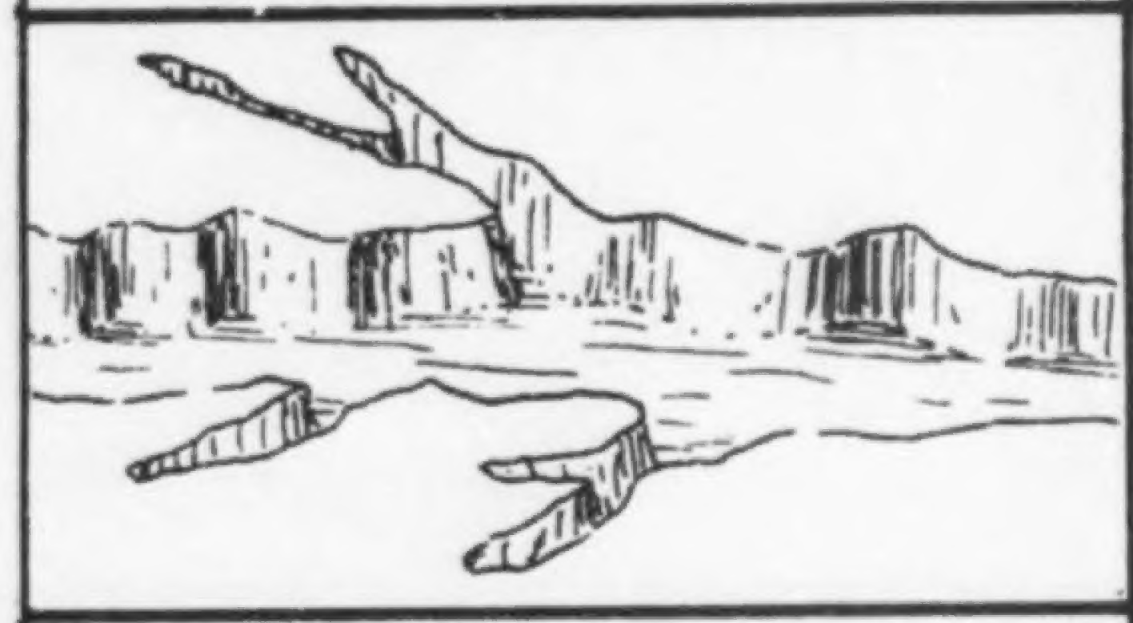
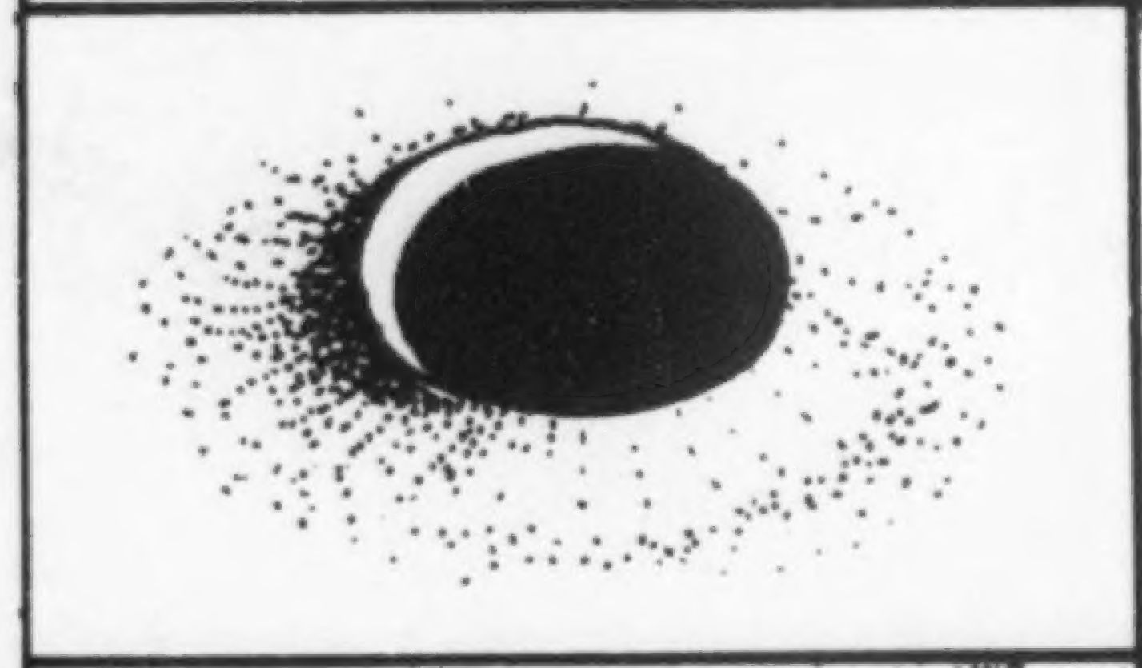
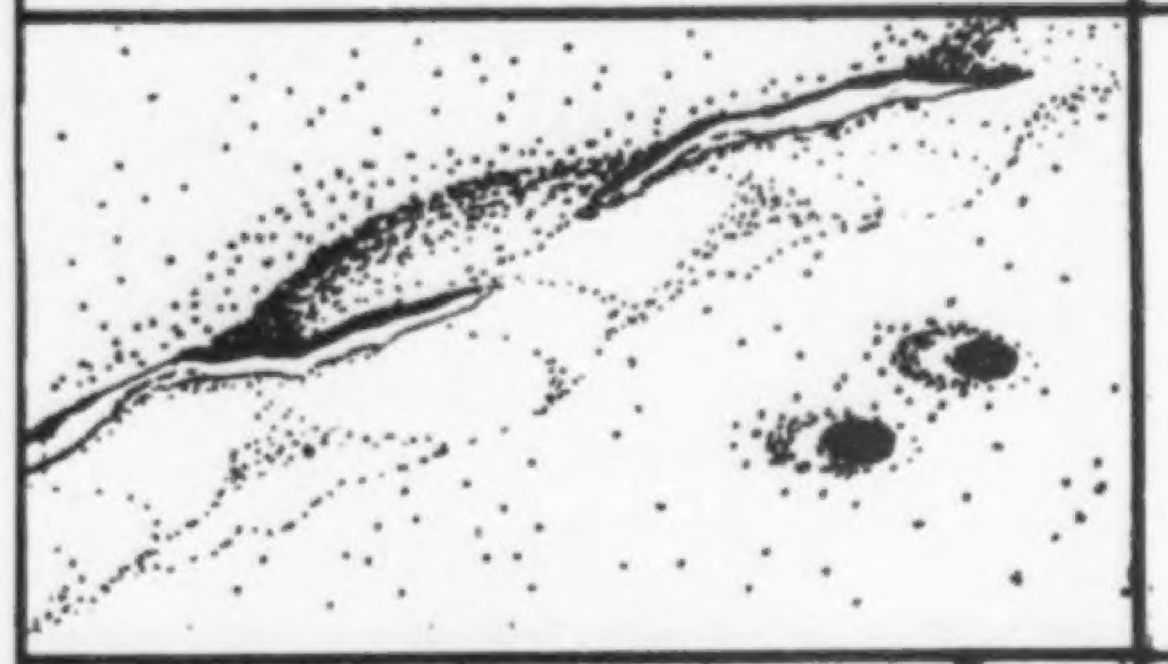
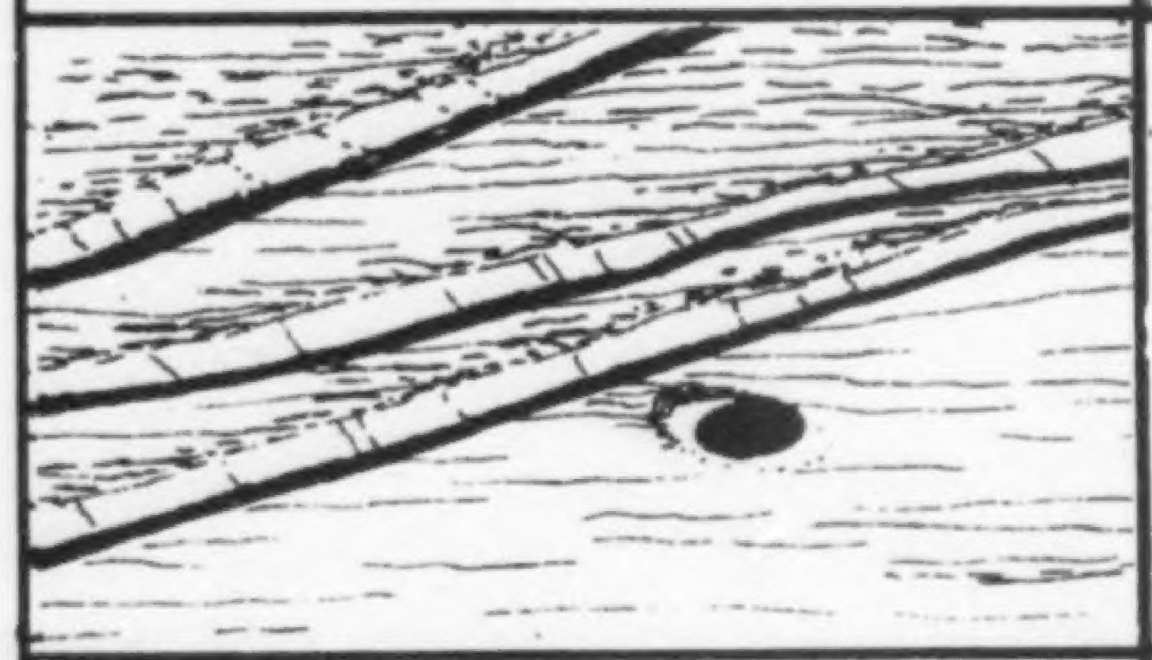
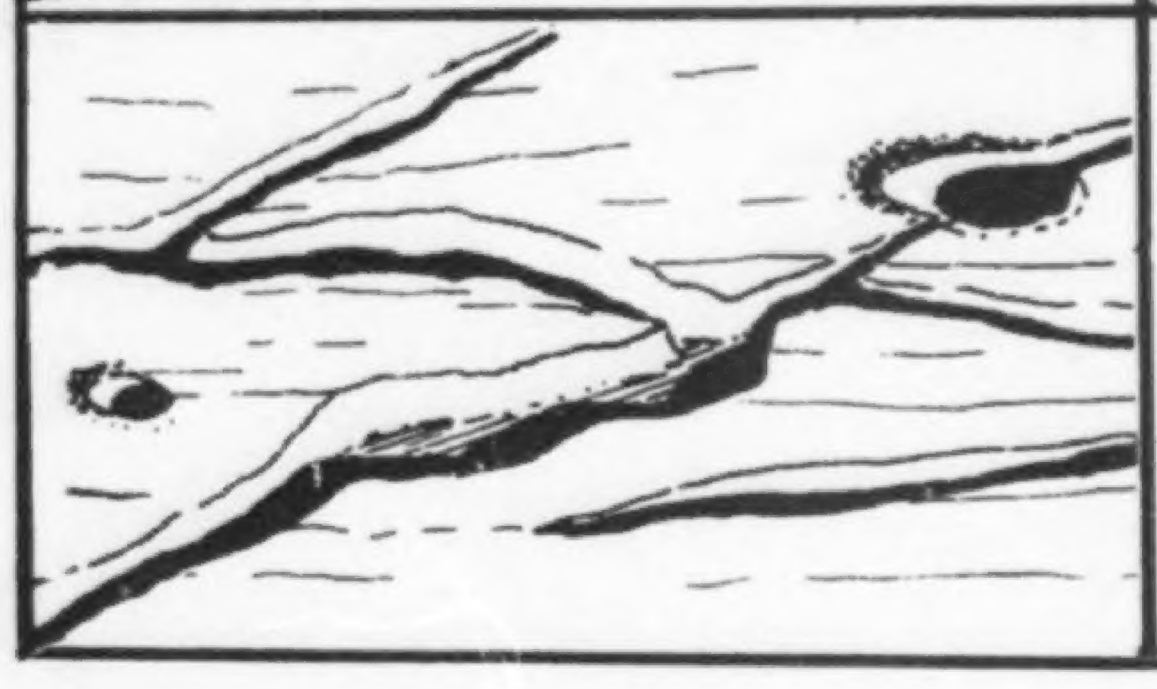
about planetary feature terms

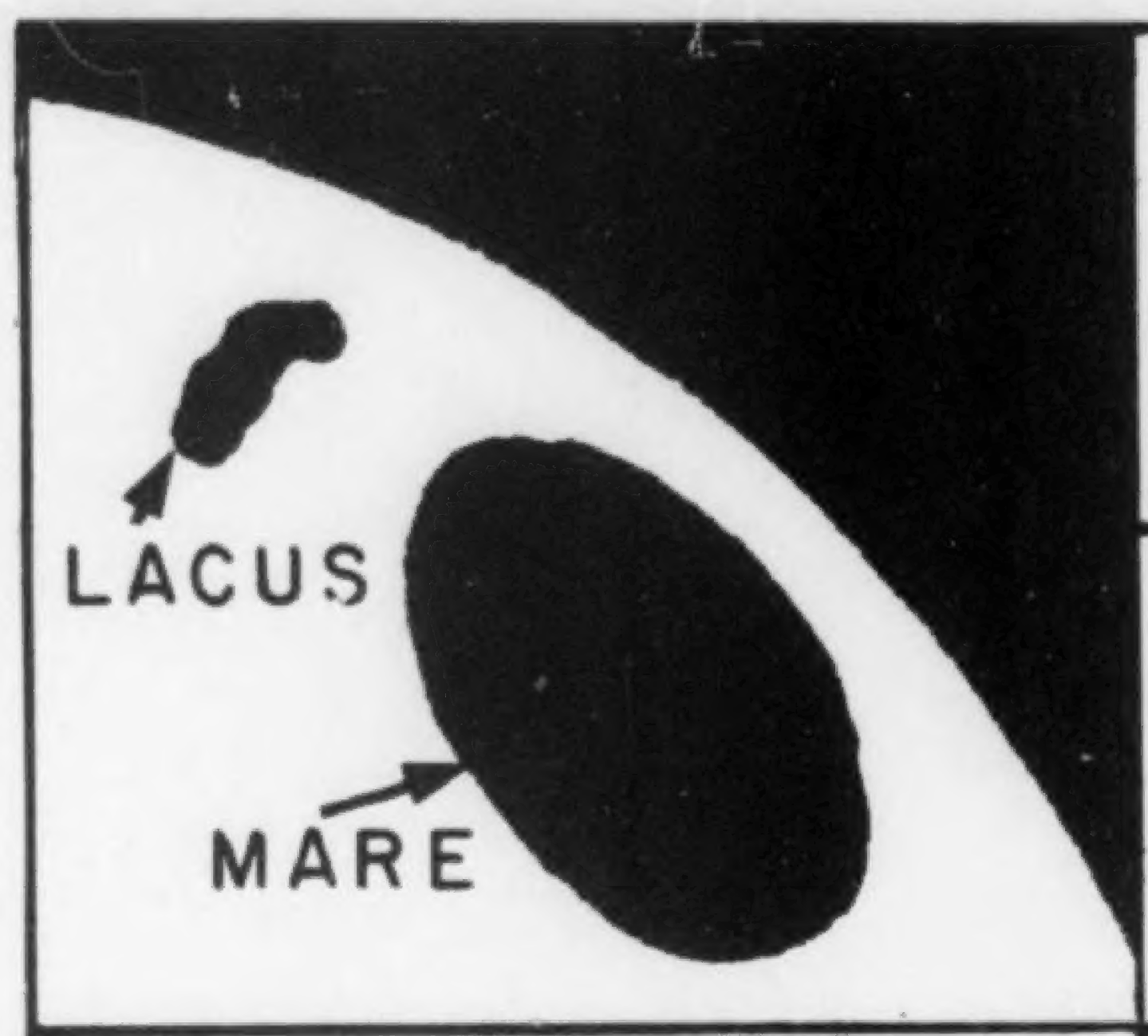
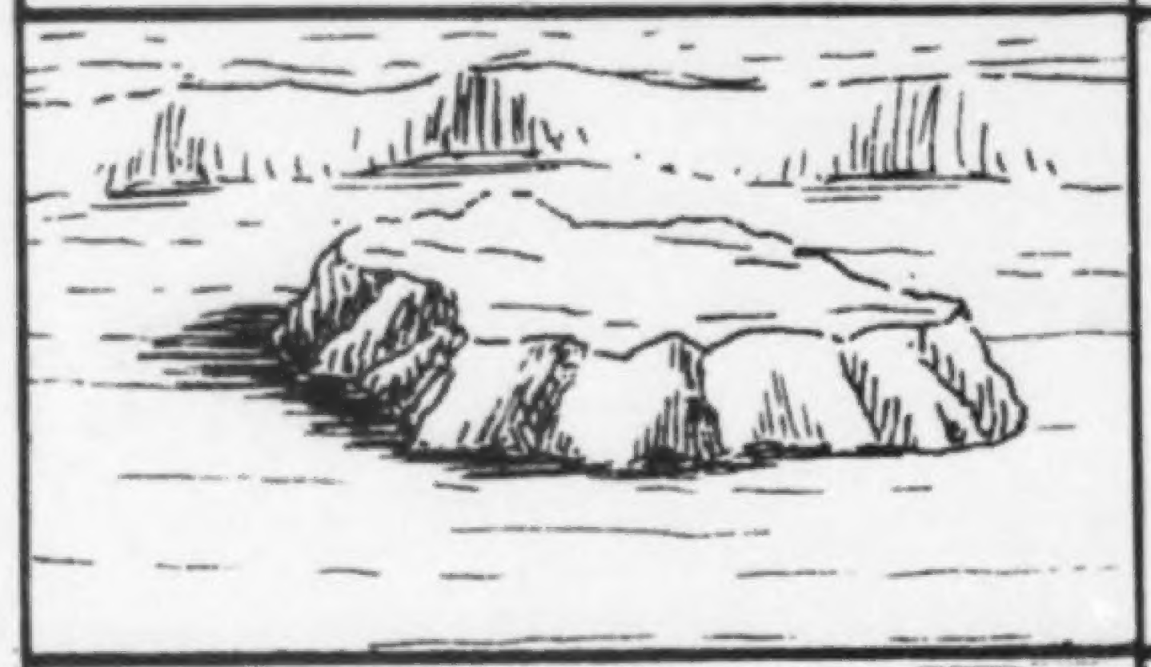
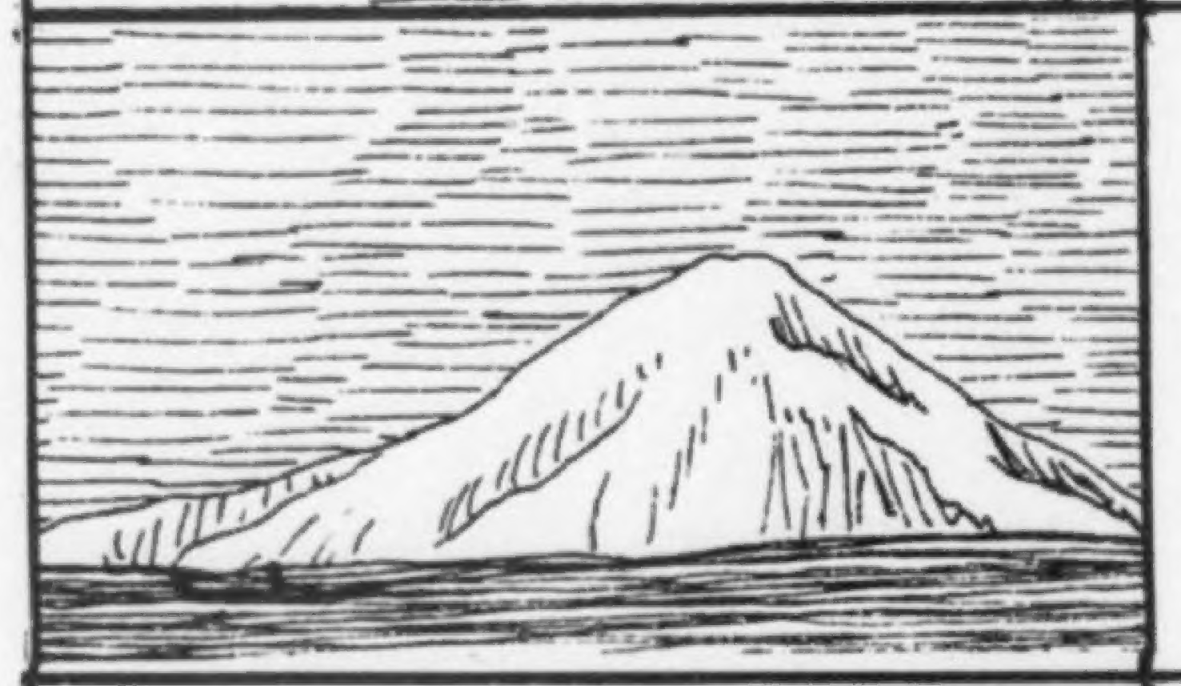
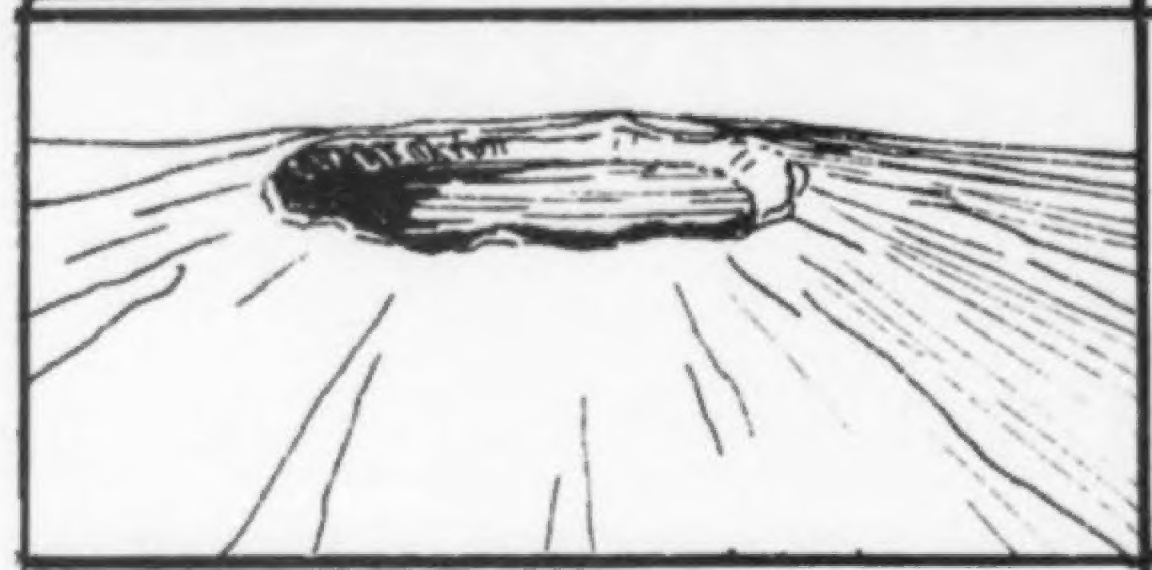
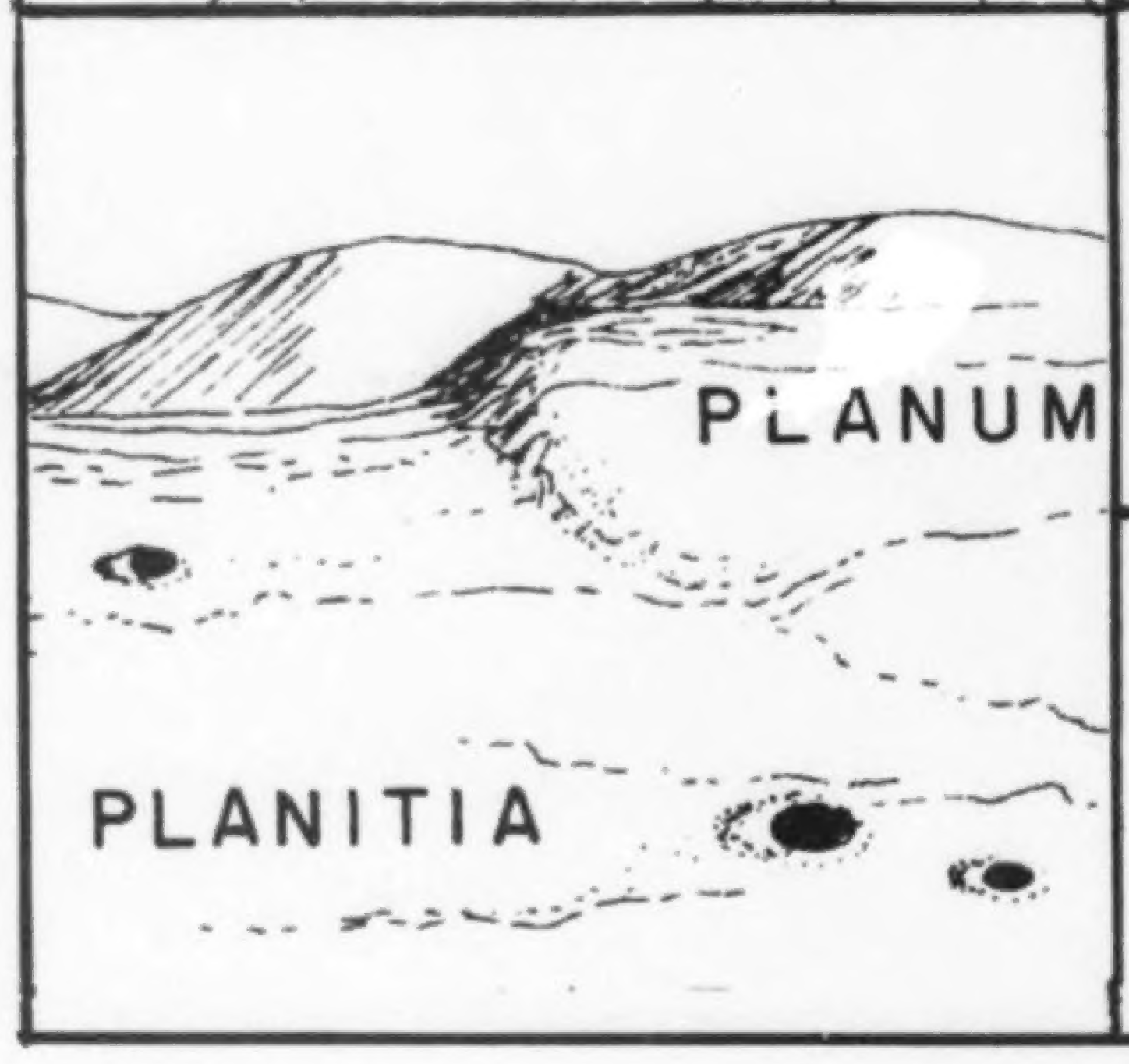
by Ann Gifford
Research Assistant/Geologist
Center for Earth and Planetary Studies, NASM

These are the terms approved by the International Astronomical Union (IAU) to describe lunar and planetary surface features. Most terms are Latin; the plural is in parentheses following the singular term. For more on the history of lunar and planetary nomenclature, see pages 10-11.

Review each definition with students. Cut apart copies of the illustrations to construct a matching jigsaw puzzle for students to solve.

Continued on page 13

	**Catena (Catenae)** Chain; a string of closely-spaced depressions
	**Cavus (Cavi)** Cavities; irregular steep-sided depressions usually in clusters
	**Chaos** Chaos; area of distinctive broken or jumbled terrain
	**Chasma (Chasmata)** Chasm; steep-walled trough; large canyon
	**Crater (Craters)** Crater; any roughly circular depression resulting from impact or volcanic activity
	**Dorsum (Dorsa)** Ridge; elongate raised structure; wrinkle ridge
	**Fossa (Fossae)** Ditch; narrow linear trench (on the Moon, called Rima)
	**Labyrinthus (Labyrinthi)** Layrinth; an expanse of intersecting canyon-like troughs

	**Lacus (Lacus)** "Lake"; small, irregular patch of dark, smooth material on the Moon
	Mare (Maria) "Sea"; large, often circular, region of dark smooth material on the Moon
	**Mensa (Mensae)** Mesa; flat-topped elevation with steep walls
	**Mons (Montes)** Mountain
	**Patera (Paterae)** "Saucer"; shallow, complex crater with scalloped walls
	**Planum (Plana)** High plain or a plateau
	Planitia (Planitiae) Low plain or large level expanse of lowlands

NATIONAL AIR AND SPACE MUSEUM
THE SMITHSONIAN INSTITUTION
WASHINGTON, DC 20560
Jan W. Steenblik, Editor, *Air & Space*
Room 3569

Non-Profit Org.
U.S. Postage
Paid
Permit No. 3055
Beltsville, MD

159110
MS MARLENE HURST, MGR PUB REL
UNIVERSITY MICROLFIMS INTL.
300 N. ZEEB RD.
ANN ARBOR, MI 48106